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ALT-C 2007: Beyond control

Learning technology for the social network generation

Research Proceedings

Edited by Steve Wheeler and Nicola Whitton

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Editorial

The 14th annual conference of the Association for Learning Technology seeks to showcase current uses of learning technology, and inform the professional and academic community of possible future trends. The research papers strand of the conference is particularly vital in this task as it presents reports on current evaluations of emerging technologies, as well as research conducted into new uses of established technologies. The 18 papers contained within this volume have once again each been subject to rigorous scrutiny from at least two expert reviewers. The papers represent the work of leading learning technology researchers from the United Kingdom, Australia and South Africa and we are confident that they will inform, challenge and inspire.

Take a cursory glance at the title of this year's conference and you would be forgiven for thinking it is about chaos or loss of direction. Indeed, many social web spaces appear to be chaotic and inchoate, but beneath, there is usually a clear underlying purpose. 'Beyond control' raises issues about the nature of learning technology, and highlights its pedagogical implications. Implicit within the title is the ever changing role of the educator and the relationship teachers have with learning technologies. Indeed, educators should ask themselves whether they can, or should, control the emerging digital spaces that are popular with their learners. Students may be provided with managed learning environments and email within their institutional infrastructure, but the social network generation naturally transgresses these boundaries, connecting, sharing and collaborating through mobile and social technologies, and using technology to learn in creative and unexpected ways. The rise in popularity of a myriad of social networking services including FaceBook, MySpace, Bebo, YouTube, Flickr and MSN attests to this phenomenon. Whether 'learning' of a formalised nature is taking place through such activities has yet to be determined, and questions are also raised over the validity of current delivery and assessment methods in this environment. Nevertheless, engagement of this nature certainly prepares students for a world of learning and work where collaborative technology is playing an increasingly pivotal role. Managed learning is migrating toward personalised learning, reflecting the choice of the tech-savvy individual, and there has never been as much technology choice available as there is for today's student.

'Beyond control' thus connotes a move away from formal, institutional control of learning technologies toward informal, personalised learning environments, and many of the research papers contained within this volume depict and comment upon this trend. This volume of research papers is divided into four parts, representing the four conference themes:

- Part 1: Designing Learning Spaces
- Part 2: Learning and Internationalism
- Part 3: Large-scale Implementation
- Part 4: Learning Technology for for the Social Network Generation

Part 1: Designing Learning Spaces

The two papers in this first section focus on how learning technology can be used to frame the spaces within which students learn. Drawing on interviews from four diverse case studies, Robyn Smyth, Sarah Stein, Peter Shanahan and Carina Bossu (University of New England, Australia), discuss how students' perceptions of videoconferencing have enabled them to provide quality support for their distance learners. Smyth and colleagues show how this established technology can be used as a rich medium to support and enhance student centred learning. In the second paper in this theme, Michael Morgan (Monash University) proposes a framework for the evaluation of the cognitive impact of information and communication technologies on learners. He engages with the debate on technological

affordances, and considers the usefulness of a range of definitions of affordance in the context of educational technology, before presenting an alternative framework using Vygotsky's concept of 'mediation'. Morgan presents a scheme for evaluating the cognitive impact of ICT in education based on the affordances and constraints of the technology. The example providing consideration of the use of iPods in education is particularly useful for demonstrating how the evaluation framework can be used in practice.

Part 2: Learning and Internationalism

Laura Czerniewicz (University of Cape Town, South Africa) reviews the overarching notion of 'educational technology' and argues that it is an emergent field of expertise rather than an underpinning series of features in education. Through a comprehensive literature review, she delineates the boundaries of educational technology and differentiates between scholarly and professional knowledge. Czerniewicz concludes that consensus and coherent articulation of a clear definition of 'educational technology' is needed if effective communication is to be achieved between researchers and professionals. Following on, Elena Luchinskaya's paper (Manchester Metropolitan University, UK) entitled *'Collaborative knowledge building through online reflective journals: A Russian case study'*, draws upon the work of Russian theorist Mikhail Bakhtin to assess the value of computer mediated communication. Luchinskaya explores how online reflective journals can be employed as tools to promote collaborative knowledge construction in Russian social welfare.

Part 3: Large-scale Implementation

The sole paper representing the theme of 'Large-scale Implementation of learning technology' is authored by Liz Falconer and Manuel Frutos-Perez, from the University of the West of England, UK. Entitled *'Accommodating multiple learning styles and abilities in a large-scale online learning resource'*, Falconer and Frutos-Perez outline the pedagogical and technological implications of designing large-scale online resources, and how these can cater for a variety of learning styles and abilities. During their presentation at the conference the authors intend to give a live demonstration of the online resource.

Part 4: Learning Technology for for the Social Network Generation

By far the most populated section of this research paper strand, our final collection of papers focuses on emergent themes and practices relating to the social networking phenomenon and the capabilities of web-based multimedia tools that can provide rich learning opportunities.

Peter Thomas, Neil Smith and Kevin Waugh, from the UK Open University, take a five-stage approach to understanding the automatic grading of student diagrams and demonstrate how closely the software can match human marking. They show how the automatic algorithm can be successfully used to capture, process and grade graph-based diagrams in most exam situations.

The pedagogic value of podcasting is assessed by Lyn Atkinson, Andrew Buntine and Rodney McCrohan (RMIT University, Australia) in the next paper. This study used a survey approach to assess whether students on a number of undergraduate business courses would use podcasts as part of their learning, and what the preferred format of use would be, comparing streaming media, download of audio and use of RSS feeds. A great deal of detailed information regarding responses from students, lecturers and technical staff are provided, providing insights into the applicability and actual student use of audio in this study. The impact of podcasting is also investigated by Marialuisa Aliotta, Simon Bates, Keith Brunton and Adam Steven, all at the University of Edinburgh, in the context of undergraduate physics teaching. This study however examines the use of audio as a pre-

lecture study aid rather than aiming to provide a lecture alternative or revision tool. A comparative experimental design is employed and an in-class electronic voting system used as a quantitative data collection method; the description of the evaluation and questions used provide useful background to the method. Some interesting results are presented with pointers for the production of effective podcasts to support learning.

A third paper on podcasting is presented by Leon Newnham and Charlynn Miller (University of Ballarat, Australia), who focus on student perceptions of the usefulness of podcasts that were provided to supplement lectures for revision and exam preparation. Online questionnaires were used to collect opinions from the 44 students who took part in the study. The paper provides a detailed range of descriptive statistics describing the results, examining how students used the podcasts and their perceptions of the learning experience. This paper also offers an interesting consideration of the effects of a range of demographic factors on perceptions. Podcasting is also picked up as a topic for study by Mark Lee, Anthony Chan (both at Charles Stuart University, Australia) and Catherine McLoughlin (Australian Catholic University) but these researchers look at the development of audio learning objects from the angle of volunteer students as creators as well as users. The study describes the podcast production process in some detail, which provides a useful overview for anyone unfamiliar with the development and distribution of audio. A small-scale research study is described, which focuses on the meta-cognitive knowledge evidenced by the students taking part and provides a systematic framework for analysis of areas of meta-cognition and knowledge building.

The next two papers focus on how technology can be used to support students with disabilities. Iain Stewart, Malcolm Allan and David Harrison of Glasgow Caledonian University, report on the subject of widening access and how tools have been developed to support students with hearing impairments. They outline pedagogic factors specific to deaf students and note some of the barriers that can be overcome using a product called *'Talkshow'*. Evaluation of the tool unearthed several benefits and limitations, but results overall showed that the prototype generally improved communication for hearing-impaired students, particularly within tutorial and lecture situations. Jocasta Williams and Michael Fardon, of the University of Western Australia, discuss how lecture recording systems have been introduced with the aim of supporting learning and providing flexibility for students with disabilities and medical conditions. This study focused on the opinions of students who had a acknowledged disabilities or medical conditions and used surveys with a more detailed focus group; an interesting comparison is provided of this group compared to the student population as a whole. Williams and Fardon also share some useful recommendations on the use of audio to support students with disabilities.

The exploration of mini-games as educational resources is the central theme of the paper by Alex Fraser, David Argyles and Gary Wills (University of Southampton). In this paper, the authors discuss virally-distributed mini-games and critically evaluate their pedagogic worth. Fraser and colleagues studied around 30 games and conclude that most were *'shallow, formulaic and lacking in information'*. They also identify the key features of the best three mini-games and provide advice on how these can be applied in blended learning environments to facilitate simple player interaction and assessment of learning.

William Billingsley and Peter Robinson (Cambridge University) discuss the *Intelligent Book Project*, which models content delivery through a reactive learning environment, in which students are encouraged to formulate their own solutions to presented problems. The authors report that the use of massively multiple choice testing promotes better independent thinking owing to the need to use key words to search for potential answers that are not visible on the screen. They conclude that such an approach provides students with a powerful alternative to standard multiple choice questions while creating a greater degree of cognitive investment.

Educational blogging is the theme of the next two papers in the social networking section. First, Lucinda Kerawalla, Shailey Minocha, Grainne Conole, Gill Kirkup, Matt Schencks and Niall Scalter from the UK Open University focus on the use of blogs as integrated features in course delivery. Data gathered from a sample of 795 distance learners revealed that most students are unenthusiastic about blogging as a structured activity because of time constraints. For blogging to be successfully adopted, Kerawalla and colleagues recommend that students are encouraged to view it as an integral, personalised activity rather than an additional task and must appreciate how blogs differ from discussion forums, email and wikis. Next, Rebecca Ferguson, Gill Clough and Anesa Hosein, also at the Open University, discuss the use of postgraduate blogs as research journals, and describe how research experience was influenced as a result. They describe a small-scale in-depth study that examined the potential of using blogs to build a community of researchers and to facilitate the sharing of ideas. Four blogs used over the course of a year were analysed and a detailed breakdown and discussion of the postings is provided, offering some valuable insights into the use of a range of blog features that can be used to support collaboration and the research process.

Appropriately, the two final papers in this volume initiate a useful debate about the nature of 'digital students' and their use of technologies such as instant messaging, mobile phones, blogs, wikis and MP3 players. Diana Andone, Jon Dron, Lyn Pemberton and Chris Boyne at the University of Brighton identified a number of key 'digital student' attributes and preferences. Participants were asked to select five key words which described their e-learning experience, and present the results as tag clouds. Andone and colleagues report that this study has influenced the design of their e-learning provision, notably in the deployment of mobile-phone-based services. Amanda Jeffries, Nuzhet Quadri and Diana Kornbrot follow on from this theme with a paper that focuses upon student expectations and their perceived barriers to the use of learning technologies. More than 600 students reported their perceptions based on previous experiences, with around 74 per cent stating that they were confident in the use of technology. Jeffries and colleagues conclude, not surprisingly, that a key factor for the successful future implementation of learning technologies will be to ensure that teachers themselves are enthusiastic and confident adopters of new technologies.

We believe that the papers presented here provide a number of insights into the use of different emerging technologies for learning, collaboration and reflection, which highlight the innovative, and sometimes highly unpredictable, ways in which teachers and learners interact with technology. We hope that as in previous years the ALT-C 2007 research paper strand will be instrumental in promoting healthy and well-informed debate at the conference, and that it will generate questions leading to further research. We are confident that the papers within this volume will help toward preparing us for an educational future that in some ways at least, will be beyond our control, but not out of our reach.

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PART 1

Designing Learning Spaces

PAPER 1063

Lecturers' perceptions of videoconferencing as a tool for distance learning in higher education

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Abstract

This paper explores the findings of a study into the potential usefulness of videoconferencing at one of Australia's leading distance education universities. The University of New England

(UNE) is a regional university with a long distance education tradition and high reputation for supporting distance learners.

The study included an online survey and interviews of participants in four diverse case studies. It occurred early in the adoption of Internet-based broadband videoconferencing and was intended to provide base data and initial insights into the potential for the technology to be useful in a distance education setting. Since the study was concluded, several off-shoot projects have commenced. These projects support the initial conclusion that Internet-based broadband videoconferencing has great potential for supporting distance learning and learners.

Introduction

Although the University of New England (UNE) in Armidale, Australia, has a long history of videoconferencing, its primary use has been for staff recruitment rather than teaching because earlier telephone-based technology did not easily facilitate interactive or student centred learning and teaching.

Prior to the introduction of Internet-based videoconferencing technology, opportunities to use the richness of the videoconferencing medium for teaching to Australian and international sites were confined by cost, poor technical quality and unreliability. Since UNE's adoption of broadband technology the potential of the videoconferencing medium to enhance quality teaching has been increased because the technology is more reliable and cost effective (Davis and Weinstein, 2005) and able to support four key aspects of rich communication previously limited:

- audio-visual richness of synchronous communication not affected by obvious audio delay,
- increased variety of interactive teaching learning experiences that could be adapted from face-to-face situations,
- increased potential for student engagement in active learning and student control of learning,
- reliable teacher-to-student and student-to-student audio-visual communication (Greenberg and Austin-Li, 2005).

Wisdom from relevant international literature and practice (Bossu, Stein, Smyth, and Shanahan, 2006; Davis and Weinstein, 2005; Greenberg, 2006; Motamedi, 2001; Pitcher, Davidson, and Goldfinch, 2000) indicates the potential of videoconferencing to save time and cost of staff and students travelling to and from intensive schools and campuses, engage distance students more actively in their learning and provide satisfying communication for all parties. However, issues have been raised, relating to:

- staff and student attitudes towards technology-based teaching and learning and the influence that attitudes can have on teaching and learning effectiveness (Jennings, Dunne, and McShea, 1997; Johnston, 1999; Jones and Richardson, 2002; Stein, Ginns, and McRobbie, 2003),
- the role that staff development and student support strategies can play in minimising the negative effects of using the technology like frustration with technical malfunction (Brown, Myers, and Roy, 2003; Fillion, Limayem, and Bouchard, 1999; Furr and Ragsdale, 2002; Grooms, 2003),
- the need for appropriate strategies for teaching internationally (Cowan, 1996; Drake, 1996),
- how the soft/hardware applications such as presentation or data sharing software might be integrated effectively into teaching practice to add value to the videoconferencing experience.

With these issues in mind, this project, based in the UNE context, aimed to contribute to existing knowledge of practice with a view to examining the potential of videoconferencing to

improve outcomes for distance students by increasing face-to-face communications and provide staff with an additional teaching tool for interacting with remote students.

Theory

Internet-based technology enables videoconferencing that more closely approximates regular face-to-face communication than earlier telephone-based videoconferencing by supporting participants' access to synchronous verbal and non-verbal communication. While there have been notable and innovative practices demonstrated in teaching and learning using telephone-based video-conferencing (Landis, 2001), the more recent developments in the technology have meant that many of the drawbacks of the technology have been reduced (Laurillard, 2002) so that when using internet-based videoconferencing participants are better able to see and hear:

- multiple visual and aural cues in natural language communicated in real time;
- body language and intonation of speech; and
- immediate feedback which increases the personalizing of learning.

Internet-based videoconferencing is technically superior to telephone-based videoconferencing, thereby providing opportunities to enhance distance teaching, learning and supervision through, for example, reducing student isolation (Smyth, 2005a, 2005c).

The means by which academic and teaching staff utilise videoconferencing and integrate the technology appropriately into any curriculum design will define the opportunities available for students to engage effectively in learning via this improved medium. On a continuum of increasing student-centeredness the range of teaching and learning interactions utilising videoconferencing could be expanded from the traditional lecture format (teacher to many students), which was most cost effective in the past, to a range of small group activities (teacher to a few students) and student-initiated interaction (student to student/s) (Smyth, 2005b). At UNE, in some instances, cost savings to students who do not need to attend the main university campus, and to the university for staff travel to capital cities to conduct intensive schools, could be significant because travel frequency and, perhaps distances could be reduced.

The reliability and high video and audio quality of Internet-based conferencing have been demonstrated internationally (Greenberg and Austin-Li, 2005; Nilssen and Greenberg, 2006). Trials at UNE show the potential for the real-time medium to support learning through students' virtual participation in a wide range of activities including music master classes (Jim Scanlon, 2003; J Scanlon, 2003).

From our earlier research we were aware that the perceptions, attitudes and conceptions teachers and students hold about technology influence the ways they use and apply technological ideas and practices in educational settings (Stein et al., 2003). Similarly, we were aware that staff development and the implementation of student support strategies can assist teachers and students to develop appropriate conceptions, attitudes and perceptions about teaching and learning with, through, and about technology. The intent in promoting positive beliefs would be to help staff and students to develop relevant coping and management skills and minimising the negative responses to events such as technical malfunction (Brown et al., 2003; Fillion et al., 1999; Furr and Ragsdale, 2002; Grooms, 2003).

Appropriate staff development takes into account the various needs of teachers as learners themselves (Cochran-Smith and Lytle 1999; Jennings, Dunne et al. 1997; Johnston 1999; Jones and Richardson 2002). Where staff development needs in technology and technology education specifically are concerned, many teachers have everyday knowledge, but often need help in making that knowledge explicit for application in teaching and learning situations. They need to be able to experience what it feels like to teach using new

technologies and to experience how their students and they react and respond in the new environment that results. Opportunities for staff to experiment and simply to 'have a go' are important, therefore. Teachers also are interested in their students' learning so appropriate staff development should have a purpose beyond simply 'having a go.' Professional development that focuses attention on student learning outcomes and teacher facilitation of student learning outcomes can be powerful in bringing about change in thinking about how learning and teaching can happen in the environment in which the new technology has been introduced.

Also, the role of the institution, the infrastructure and the wider notions concerning change, change processes and personal reward should be recognised and acknowledged in any appropriately designed and implemented staff development program (Guskey, 2002; Laurillard, 2002; Smyth, 2003). The surrounding institutional context has been shown to be key in supporting professional development through providing not only resources, but also motivation for teacher learning and development through reward and recognition.

Finally, our experience with remote students using UNE's Access Centre network and our international partnerships showed that it was technically possible and pedagogically desirable for on-campus Armidale students to engage in interactive learning opportunities with regional and international students studying similar subjects. We theorised that various forms of student-to-student interaction could enhance cultural awareness, global perspective and communication skills through team and group work, mentoring, peer collaboration and review or practice without penalty prior to assessment or supervision. Similarly, we were aware that the technical capacity to capture, archive and stream videoconferencing for asynchronous use would provide new opportunities for enhancing distance learning, once the reach of wireless broadband extends throughout Australia.

Therefore, the project sought to draw together these experiences, our theorising and emerging research literature to gather evidence concerning staff perceptions of the improving technology since these would be critical to decision-making about extension of videoconferencing as a means of supporting distance learning.

Method

Our investigation of videoconferencing for teaching and learning was contextualised for the distributed environment of UNE Access Centres which are 24/7 student support centres located across the north of NSW from 100–300kms from the main University of New England campus and also, international partner institutions located in Asia and the USA.

The research aims of the project were to

1 investigate staff perceptions about using videoconferencing for teaching in various disciplinary contexts, internationally and to remote campuses
2 investigate the influence of staff perceptions on teaching practice related to using videoconferencing
3 recommend appropriate support strategies for both staff and students to participate successfully in flexible and inclusive teaching and learning via videoconferencing.

The methodology for the study was mainly qualitative in nature, based on an action research approach (Carr and Kemmis, 1986). To achieve the first research aim, an online survey was circulated to staff at UNE concerning their perceptions about using videoconferencing for teaching and learning in their particular disciplinary contexts. The questions in the online survey were a mix of predefined selections to be made (specifically about demographic information ad experience) and questions prompting free form answers. This data was to provide baseline data for the University. Questions that made up the online survey were derived from themes in relevant literature concerning teachers' implementation of technology

to aid teaching. For example the level of technical expertise teachers require, selection of suitable pedagogical approaches, degree of awareness of students' needs and expectations, impact of frustration and inappropriate use of the technology (Laurillard, 2002).

To achieve the second research aim, data were gathered from 4 groups of lecturers who volunteered to experiment with videoconferencing, representing a cross section of/variety of different discipline areas and teaching approaches. Experience with using videoconferencing varied from none to reasonable familiarity. Interviews were conducted face-to-face immediately following a videoconference session to elicit participant feedback and reflections on their experiences and on the teaching approaches and strategies used during experimentation. Field notes of researcher observations of participant interactions during the experimentation were also made in addition to video and/or audio recordings with participant consent.

Finally, the third aim was achieved by reviewing all the data and reflecting on the UNE context and wider research literature. In the light of this review, recommendations for further action to support staff and students were made.

Overall, the action research methodology (Gibbs, 1995; Kock, 2001) was used to suggest, test, refine and review assertions concerning the experiences and understandings of the participants about using videoconferencing to support their teaching and learning activities in the light of issues derived from the literature. This methodology links theory and practice to derive an holistic understanding of a particular situation (Kemmis and McTaggart, 1990). Qualitative data analysis of transcripts and field notes enabled the research team to interrogate relationships between perceptions and practice, intentions and outcomes with a view to making judgements and recommendations for practice and research.

Contribution

The online survey advertised across the university's local area network yielded a disappointingly small self-selecting sample (n=23) which represented only 5% of the academic staff of the institution. Some reasons for the poor response rate could include the newness of the technology to many staff, lingering concern that technical difficulties and cost implications associated with earlier versions of the technology which remain as barriers to experimentation or simple ignorance. This is an area for further research but there were some indications in qualitative data to support these suppositions. For example, staff comments included: *I understand that a charge will be made in the future. This would be a mitigating factor and Differing communications infrastructure can make communication difficult.*

The second form of data gathering occurred via interviews of staff engaged in using videoconferencing. Different applications of videoconferencing were explored in the case studies detailed later in this report.

The sample

The demographic characteristics of the sample showed just over half (12 out of 23) of the respondents were lecturers with 0–5 years experience teaching in the tertiary sector, aged over 40 years, from all disciplines and evenly balanced in numbers of males and females. Many respondents were not regular users of videoconferencing and the majority (22) had used it less than three times per semester in the previous year and mainly for meetings rather than teaching. Almost half of the group (12) rated their level of expertise as 'satisfactory'. Similarly, the majority (20) taught by distance within Australia and/ or internationally and rated videoconferencing as 'very useful' or 'useful' to their current teaching role. Only 5 respondents indicated that they could not see usefulness in videoconferencing in their current role so 80% would be interested in increased use of videoconferencing for teaching.

The data

The most likely uses for videoconferencing included: guest lectures (14), facilitated discussions (13), tutorial discussions (12), post graduate supervision (12), student support/correction (11) and group presentations (8). No-one indicated that videoconferencing would be used for practical experiments in Science although six respondents indicated that they may use it for practical demonstrations and two for oral/practical class/examination.

From the qualitative data about videoconferencing in the online survey, the most common positive comment about videoconferencing related to its capability to support interaction between students and lecturers. Particularly for post graduate supervision and group interaction, videoconferencing was regarded as having great potential by respondents who had already experienced it. Two questions probed the potential of the technology, namely, *What is your understanding of the benefits of videoconferencing for teaching purposes?* and *In your current teaching role how useful would you rate videoconferencing?*

A variety of potential and current uses of videoconferencing were reported by respondents, including the possibility of "replac[ing] some or all of several compulsory residential schools, particularly when lectures, rather than practical skills make up the res school content"; and "conduct[ing] an end-of-semester class with students at the UNE Access centres".

Respondents recognized the close and immediate interactions with students that videoconferencing makes possible. This included the idea that personal relationships, especially during long term research student supervision, were important for supporting good teaching. Some examples of responses included:

> *It's good to see the body language of participants and I think the communication is better because of this.*
>
> *You are actually able to see the students and make real contact with them—start to develop a relationship which is so important in post graduate supervision.*
>
> *Immediacy, allows for approximation of face-to-face, possible combinations of vid conf group(s) with in camera room group. Could be used well for Higher Degree Research supervision.*
>
> *I do a great deal of teaching NESB students overseas. These students really appreciate personal contact with their professors. So I see videoconferencing most useful to augment, not replace, traditional means of communicating.*

Others simply noted the positives for students including the potential to reduce the feeling of isolation that distance students can often feel, and also in terms of cost savings for them. For example,

> *Contact! External students tell me they feel isolated from UNE when they go home after residential schools and others don't have any residential schools in my subjects.*
>
> *Face to face communication with students but also potentially student to student, savings on travel costs.*

Finally, one respondent pointed out that videoconferencing for teaching, "gets us working in an environment which is commonplace in many of our students workplace learning and working arrangements", indicating the importance of being able to communicate in ways that students themselves use in their everyday lives.

These data have a richness which can inform future decision making and practice despite their limited generalisability from such a small sample.

Overall, responses showed a diverse range of generally positive perceptions which also highlighted issues and implementation barriers, which are both perceived and real. For example:

> *Not used for teaching but can see its potential. Have made this suggestion but costs from other end too high.*
>
> *I have used videoconferencing in the past and see it as a valuable teaching tool. …. There is an obvious benefit for those students who would normally not have much contact with lecturers during their course due to distance. I believe that it is more appropriate for discussion rather than lecture style presentations (depending on the lecture!!)*

In the online survey perceived limitations of videoconferencing were most commonly reported as technical ones such as audio lag, drop out rates and costs which we now see being overcome in successive generations of videoconferencing soft and hardware, e.g.

> *sites keep dropping off*
>
> *delay in reception of audio and technical limitations and time zones will also impact on the use of video-conferencing to off-shore campuses.*

In addition, some staff did have concerns about pedagogical issues which will require further probing in future studies:

> *I see there are limitations in providing one on one assistance within tutorials, providing effective interaction where there may be language difficulties and providing a practical and scenario based tuition for the type of subject matter that I teach.*

On the contrary, an alternative view from the same discipline area showed the breadth of opinion being expressed in this early phase of implementing broadband videoconferencing:

> *Videoconferencing underpins the UNE/California State University Fullerton (CSUF) partnership in which the UNE PhD is delivered, using a supervisor from both Universities. The videoconferencing studios at both Universities have been used to enable whole group sessions (with supervisors from both Universities) as well as more individualised sessions with the two supervisors and the student. Such sessions have been very valuable, firstly in enabling the staff and students to meet each other, and secondly in discussing the research proposal and other related matters.*

This view is supported by evidence from academic skills programs being delivered via videoconferencing. Lecturers from UNE's Academic Skills Office (ASO) run tutorials on essay writing and similar activities. These programs enhance writing and study skills, promote social and intellectual integration into the university, and develop confidence and motivation for students to continue with their studies. Student evaluative data from these programs reinforces that the videoconferencing sessions are most worthwhile because they contribute to student engagement and persistence (Tinto, 1987 p. 119). For example, following a videoconferenced ASO workshop, this unsolicited comment was received the next morning:

> *I was at the Gunnedah Access Centre for the video conference last night on essay writing. I just quickly wanted to thank you and to let you know that I found it extremely helpful. … I* would *appreciate the opportunity to attend any further link ups that you might organise.*

In terms of the final aspect of the online survey, staff development needs and preferences, respondents indicated that they would like to learn more about teaching and learning techniques (15), using UNE Access Centres (13), technical processes (9) and off-shore teaching (8). As for the mode of staff development, the main preference was for hands on modes such as face-to-face tuition (9), scheduled workshops (8) and demonstrations in schools or departments (9). Self paced instruction (5) and frequently asked questions (FAQs) on the web (4) were less preferable than expected and this may be related to the newness of the current generation of intuitive 'plug and go' videoconferencing.

The case studies

Four current user groups provided valuable insight into the parallel potential of videoconferencing to impact on the broader research, service and administrative functions of academic staff:

1. The National Centre of Science, Information and Communication Technology, and Mathematics Education for Rural and Regional Australia (SiMERR) utilises videoconferencing for hub meetings and collaboration. SiMERR has established a hub in each state and territory, and videoconferencing brings the centres together more than would otherwise be possible given the vast distances across Australia. Videoconferencing has helped to save money and time, as collaborators do not need to travel long distances to attend meetings and, most importantly, videoconferencing provides more frequent opportunities for sharing knowledge, problem solving and managing the research project.
2. The Small Enterprise Association of Australia and New Zealand used the technology for professional development in the form of a 1-day conference linking six remote sites to UNE and to guest speakers. Videoconferencing was a cost effective way of conducting this activity and, particularly in attracting busy guest speakers. The conference organiser commented that “the ability to communicate across such a distance is a good example of how the technology can be used to reduce distances”. Field notes taken during the conference also highlighted many of the commonly found pedagogical and remote learner management issues which often inhibit effective use of the technology in distance settings so this information will inform the ways in which staff are introduced to planning to use videoconferencing effectively.
3. Staff from the School of Professional Development and Leadership attempted to engage externally with internal postgraduate students during a seminar series program. Staff and on-campus students were enthusiastic about the potential of the technology but issues related to the timing of the session during business hours seemed to mitigate against participation by off-campus students, most of whom were working and studying part-time. Nevertheless, the session produced lively discussion about technical, pedagogical and administrative issues including preparation, timing, accessibility, and fit to purpose if videoconferencing is to be used as a successful teaching tool.
4. This final case study was an international case study involving UNE and the Ministry of Education in East Timor. Although the researcher at UNE declared videoconferencing sessions are not as rich as face-to-face contacts, he was very impressed with the results of the session and excited about the technology’s potential for teaching and research. In particular, the responses of the people in the far end site were more positive than he expected. The main thing he liked in the technology was that he was able to see the people he was talking to: “I can talk with them over the phone, but being able to see them made quite a difference.” Although there were some technical problems, audio and video delays, and inappropriate lighting conditions in the far end site, he felt that “people can get used to the technical problems, once there is a commitment from those involved in the programs.”

Evaluation

Our investigation was intended to yield outcomes which included:

- gaining insights into the influence of staff perceptions on teaching practice, particularly concerning videoconferencing as a teaching technology
- case studies documenting teaching strategies that utilise the richness of the videoconferencing medium to enhance teaching and learning through interaction and student centeredness across the disciplines
- directions for future research, particularly with partner institutions and other organisations.

The lessons which were learned primarily showed an increasing use of videoconferencing for purposes other than teaching as reflected in the cases presented. However, when combined with the online survey data, these four cases do provide significant insight into the potential, benefits, usefulness and limitations of videoconferencing which will inform the development of practice alongside technical expansion because they highlight fundamental issues of managing various rich media technical environments. It could be argued that because many of the staff involved in this study had had little experience using videoconferencing for teaching, their opinions of the use of videoconferencing for this purpose were not valid. However, we believe that from a staff development point of view, if these teachers are expecting to incorporate videoconferencing into their teaching, then their perspectives are important in terms of how they will influence and determine teacher responses to either wanting to take the new technology on board for themselves or having to do so because of institutional or student or professional expectations. In the light of teacher perceptions that emerged from this study, more specific implications for teaching and learning will become apparent as more staff experiment and engage with the technology.

From the online data, it was also interesting that age and experience were not necessarily inhibitors of adopting new technologies but this is a cautionary statement since the small self-selecting sample could have been biased towards early adopters without the researchers becoming aware that this was the case. Theorizing about adoption of technology could not, therefore be confirmed with any certainty despite an apparently appropriate methodology and approach to the study. Nevertheless, anecdotal reports from activities outside the project together with outcomes from a published research report exploring similar issues in relation to videoconferencing, the *Learning Through Exchange—Agriculture, Food Systems And Environment* (LEAFSE) project (Macadam, 2005), provided independent data on student support and post graduate teaching applications. The latter could be used as a benchmark for some outcomes of this project. Macadam (2005), in the LEAFSE study, concluded that videoconferencing was useful for interaction and student support:

> *Another generalised response was the videoconferences had served to maintain the sense of belonging to LEAFSE and its members that was developed during the initial workshop at KVL (p.26).*

Further corroborative evidence for the findings from our study, found in the LEAFSE project report, provided a glimpse of how the reliability and high video and audio quality of Internet-based videoconferencing was being tested at the time of our original research:

> *"technical problems posed by the number of participants (approx 40) and institutions (8 Unis) across an 8–9 hour time differences presented a major challenge. LEAFSE utilization brought a common misconception to the fore and addressed it i.e. that videoconferencing is a telephone call with pictures—the reality is that it offers enormous scope for teaching, and this was well demonstrated in LEAFSE."* (Macadam, 2005 p. 26)

He went on to say that by the end of the project the videoconferencing process was working as well as technically possible.

Despite the limitations, at UNE there seemed to be sufficient indication of increasing interest in videoconferencing in our study and subsequently, to support initiation of a project into scalability of videoconferencing for post graduate supervision interfacing web cams, 3G mobile phones and desktop videoconferencing. The results of this project, planned for 2007, will be published in 2008. In addition, it was clear from our study that there is need for further investigation into appropriate pedagogical strategies for use in videoconferencing situations, within a variety of subject and discipline contexts and purposes. Guidance can be sought from work such as that of Laurillard (2002), but to ensure that any staff development in this area is worthwhile and effective, opportunities for staff to experiment and learn for

themselves about how videoconferencing technology can influence and determine their practice and their students' learning will be necessary. Similarly, recognition will need to be given to the support required by students experiencing learning using this technology, especially for the first time.

Conclusion

This study supports existing theorizing that videoconferencing is a rich medium with the potential to enhance student centered learning. It confirms that teaching staff generally recognize the value and potential of internet-based videoconferencing for teaching, especially because of its ability to bring students and teachers closer together in distance learning situations (Greenberg and Austin-Li 2005; Smyth 2005a, b). The reliability and cost-effectiveness was also recognized (Davis and Weinstein 2005) and the ability to provide a more satisfying learning experience for distance learners (Pitcher et al. 2000) was acknowledged.

Staff perceptions of the potential of the broadband videoconferencing medium to enhance quality teaching are positive, if tentative because of lack of direct experience. This points to the need for any future professional development to take account of teachers as learners themselves(Cochran-Smith and Lytle, 1999), and provide opportunities for them to experience a variety of uses for videoconferencing and to experiment with it in their own teaching.

The technology is becoming more reliable and cost effective and has potential for research activities as one of the case studies showed. The other three case studies illustrated that videoconferencing does have potential for various types of audio-visual communication for professional development and teaching and learning.

Since the project concluded, many more staff have expressed interest in using videoconferencing and UNE has developed enhanced capacity to capture, archive and stream interaction for asynchronous access. New opportunities for research have also emerged to provide additional insight into the use of videoconferencing as a tool for enhancing distance learning in higher education.

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PAPER 1076

Evaluating ICT in education using the concept of mediation

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Abstract

This paper proposes evaluating the cognitive impact on learners of Information and Communication Technology (ICT) based of the concept of 'mediation', Vygotsky (1980), as an alternative to the Conole and Dyke (2004 a and b) concept of 'affordances'. The generic affordances proposed by Conole and Dyke were critiqued by Boyle and Cook (2004), who asked; Can a description of affordances be used to improve the practice of educators? The cognitive impact of mediating artefacts is critical to understanding ICT in learning contexts, (Morgan et. al., 2006, a, b, c) and in analysing their role and efficacy in educational practice.

Background

While the use of Information and Communications Technologies (ICT) has steadily increased in most areas of modern life over the past three decades the debate on the effectiveness of ICT in education still continues, (Anglin, 2004), with mixed results in a number of studies. Increasingly educational practitioners are confronted with a bewildering variety of options and rapid rate of change in the ICT available to them (Conole and Dyke, 2004 a). In order to analyse the nature of ICT Conole and Dyke (2004 a) employed the concept of 'affordances', (Gibson, 1977 and 1979; Norman, 1988; Salomon, 1993). Ten generic affordances of ICT were proposed including: accessibility; speed of change; diversity; communication and collaboration; reflection; multimodal and nonlinear; risk, fragility and uncertainty; immediacy; monopolization; and surveillance, (Conole and Dyke, 2004 a). However this listing of the generic affordances of ICT raises a number of problems in terms of its use to guide educational practice and research.

On examining the list of affordances by Conole and Dyke it is clear that the nature of the 'affordances' listed varies considerably. For example 'accessibility' relates primarily to a technical capability of ICT, 'speed of change' relates to the historic development of ICT, 'reflection' relates to an educational use of ICT, and 'surveillance' relates to social issues and power relationships. While all these factors may indeed be characteristics of ICT the relationship between these factors is less clear. Without a method of interpreting the relationships between these factors the utility of the affordances in guiding educational practice is handicapped. Boyle and Cook (2004) have also questioned the utility of using the notion of 'affordances' to guide educational practice by asking; Does an understanding of the affordances actually get us closer to improvement in practice and is this a useful framework? The Conole and Dyke list of affordances certainly highlights some important positive and negative aspects of ICT from an educational perspective but to move beyond this point a comprehensive analysis method needs to be developed that is based on empirical studies

into the instructional effectiveness of ICT. In other words we are not only attempting to analyse how ICT are used in educational contexts but also what learning effects are engendered. Critical here is the notion of 'cognitive impact' that can be defined as the extent to which a learning activity engenders generative cognitive processing of the content in order to modify memory schemata through the fundamental processes of 'elaboration', 'tuning' and 'restructuring' (Lutz, 2000). This generative processing for schema construction can be thought of in Instructivist or Constructivist terms.

Boyle and Cook (2004) are also critical of the notion of 'affordance', noting that it is a contested term derived from Gibson's (1977 and 1979) work on 'environmental affordances' and the work of Norman (1988) on 'perceived affordances'. After referring to the work of Gibson and Norman, Conole and Dyke (2004 a) adopt the Salomon (1993) definition of the term: "'Affordance' refers to the perceived and actual properties of a thing … that determine just how the thing could possibly be used." (Salomon,1993, p. 51). But this definition is of limited use in assessing the education effectiveness of ICT. Unlike Gibson's notion of the complexity of motion of 'an ant on a beach' being due to the complexity of the environment, in educational settings the complexity of human behaviour is in large part due to the complexity of the internal cognitions of the individual. In a similar manner the range of action available to learners is not just due to the existing designed functionality that they 'perceive' to be available in the environment as Norman would suggest. Learners will often actively and spontaneously modify and adapt the environment in unexpected ways in order to increase the range and effectiveness of their activity. Finally Salomon's definition relates to the properties of tools and how they can be used, but does not shed much light on the cognitive impact of these activities. An affordance may make a range of activity available to the learner but how do we know that the activity produces the required learning effect?

An additional issue with the Conole and Dyke use of the notion of 'affordances' is that the list is an attempt to codify a set of 'generic' affordances that apply to ICT in general. Affordances are by their essential nature bound to context, activity and actors. The same tool in a different context, or used in a different activity, or used by a different individual, may have a radically different set of affordances. After all a sheet of paper can be used to store texts as in a book, to work out the steps in a mathematical calculation, to graph a mathematical relationship, as a drawing medium, or to construct model airplanes to learn about aerodynamics. Can a discussion of the generic affordances of paper account for the cognitive impact of each of these disparate activities? It may be better to describe the Conole and Dyke list as general characteristics of ITC rather than as 'affordances'.

Theory

A more appropriate approach may be to use Vygotsky's (1980, 1986, 1999) concept of 'mediation' due to the fact that mediation examines the relationship between mediating artefacts and the internal cognitions of individuals. In this case affordances and constraints are discussed in terms of the design of mediating artefacts. Assessing the cognitive impact of ICT is an essential element for understanding learning interactions and in informing educational practice. A shift to the concept of 'mediation' allows a re-examination of the relationship between individuals and the mediating artefacts (tools) they use in their physical, social and cultural environment. Here the terminology of 'mediating artefact' is prefer to the use of the term 'tool' due to the fact that a discussion of mediating artefacts implies that there is a consideration of the cognitive effects on the learner whereas the discussion of tools has traditionally been couched in terms of task efficiency, human-centred design for user goals, and ease of use for interface design. For example we could compare two methods for solving a mathematical problem, a calculator verses pen and paper. Clearly the calculator is the superior 'tool' in terms of task efficiency and easy of use but the use of pen and paper to solve the same problem might lead to more profound cognitive effects for the learner.

According to Vygotsky ‘mediational means’ could consist of intangible symbols systems, such as language and mathematics; social relationships, such as roles and identities; or even physical tools, such as compasses and rulers. Each of these mediating artefacts has an impact on the cognitive processes of the individual who uses them, due to the cognitive activity that was crystallized or fixed during the design and construction of the tool. The cognitive activity that is preserved in the configuration of the mediating artefacts is propagated by either cultural or physical means and is later brought into coordination with the cognitive processes of individuals during subsequent activity. Pea (1993) contends “that the resources that shape and enable activity are distributed in configuration across people, environments, and situations.” (Pea, 1993, p. 50). Perkins (1993) states “The residue left by thinking—what is learned—lingers not just in the mind of the learner, but in the arrangement of the surround as well, …” (Perkins, 1993, p. 90).

Mediation and mediating artefacts

Mediating artefacts can be examined from a variety of perspectives. An early proponent of mediation in the West was Norman (1991) with his concept of ‘cognitive artefacts’. Kaptelinin outlines Norman’s definition “… “A cognitive artefact is an artefact designed to maintain, display, or operate upon information in order to serve representational function.”” (Kaptelinin, 1996, p. 62). The description of these artefacts however is limited in scope in that it only describes those mediating artefacts that tend to replicate internal functions so that they can be off-loaded to the environment. Norman gives a description of some artefacts that are used to hold representations of information externally so that individuals do not have to maintain them by using internal resources. Due to the limitations of working memory, maintaining representations of information or the current state of a cognitive process is particularly resource intensive when using internal resources. In Norman’s account, when a text is used to hold information or a diagram is used to show a relationship or a notepad is used to represent the state of a mathematical problem, internal resources are freed for other uses.

Mediating artefacts can also be used extensively to automate processes. Kuutti states that “Automation is the oldest and perhaps best understood way to support activities, but it is not the only way.” (Kuutti, 1996, p. 34). Automation is useful for freeing internal resources thereby enabling the learner to deal with more complex or critical issues. Low-level cognitive tasks are the best candidates for automation through mediating artefacts. Automation does however have some limitations in learning interactions. Due to the fact that no conscious attention is used in automated actions no learning can occur unless the process in interrupted in some manner so that the learner is required to focus on the task.

In his book, Cognition in the Wild (1995) Hutchins focuses on the physical properties of mediating artefacts. According to Hutchins the physical properties of tools and environments can be used to control activities, to coordinate the actions of several individuals, to represent the state of systems, to prevent errors, and to reduce the number of options that need to be considered. Often the physical tool changes the nature of the cognitive activity being undertaken from a computational task, such as calculating the speed and bearing of a ship navigating into port, to a perceptual task, such as drawing a line between groups of sightings marked on a navigation chart to represent the speed and bearing of the ship. In such mediating artefacts, redundant calculations are often embedded in the configuration of physical tools in order to reduce the total number of calculations required.

While some processes are difficult to represent in the environment, goals and interaction strategies, (Wright, et. al., 2000), are often successfully represented externally. Formal procedures are a common example of an interaction strategy that has been externalised. In most educational settings the goals of the activity are set by the teacher rather than internally by the learner. The learner is often in a poor position to determine the most effective goals for

learning and the most effective strategy to achieve learning due to the fact that they start as novices in an area. Therefore, the externalisation of interaction strategies has a long history. This method is efficient because guided activity is often more effective than unstructured exploration and experimentation.

It is clear that mediation forms an important element of cognition. Tool mediation is essential in the transmission of cultural knowledge that has been built up in the past and therefore enables higher levels of activity in the present. Kaptelinin states that; “Tool mediation is a way of transmitting of cultural knowledge. Tools and culturally developed ways of using tools shape the external activity of individuals and through the process of internalization influence the nature of mental processes (internal activity).” (Kaptelinin, 1996, p. 53). Mediating artefacts have an important role in shaping and influencing internal cognitive processes. It is therefore important to understand the nature and structure of mediating artefacts and to exploit their strengths to complement the internal cognitive processes of learners. The cognitive impact of mediating artefacts depend upon a number of factors according to the literature, including: i) the configuration of their affordances and constraints ii) the original context and historic development of the mediating artefact, iii) the new context of their use, iv) the nature of the learner activity in which they are used, and v) innovative uses and contexts.

The affordances and constraints of mediating artefacts, (Hollan, Hutchins et al., 2000; Hutchins, 1995; Norman 1991, Pea, 1993; Perkins, 1993; Salomon, 1993), are significant as these serve to enable, control and/or limit the nature of the cognitive activities of the user of the mediating artefact. This influence emerges as a consequence of the use of the mediating artefact and so is a powerful technique to guide the cognitions of learners into meaningful and significant forms. The original context and historic development of the mediating artefact (Cole and Engeström, 1993; Engeström, 1999; Kaptelinin and Nardi, 2006; Kuutti,1996; Nardi, 1996), is also important in understanding their nature as is outlined in Activity Theory. Mediating artefacts, in the configuration of their affordances and constraints, carry within them the aims and objectives of the original context for which they were design. For example, a tool developed in a business context will generally be designed to be efficient in terms of time to reduce labour costs, be designed to prevent or reduce errors, and also to reproduce information without alteration. As was demonstrated with an examination of the ‘Copy and Paste’ function, (Morgan et. al., 2006 a, b, c), when a tool developed in a business context is employed in a learning context it’s fundamental affordances and constraints may be inappropriate. Therefore in order to understand the cognitive impact of mediating artefacts on learners we need to understand the original context and development of the ICT tools we use. When a mediating artefact is employed in a new context its use often leads to different forms of cognitive activity, (Duffy and Cunningham, 1996; Lave and Wenger, 1991; Suchman, Pea et al., 1987). The introduction of a tool changes the nature of the cognitive activity as the user coordinates their internal cognitions with the use of the tool. According to Suchman et. al. cognition is ‘an emergent property of activity’ while Lave and Wenger frame cognition in terms of participation in a ‘community of practice’. Tools, procedures and processes, and rules and social relations are all forms of mediating artefacts that influence cognitive activity. The nature of the learner activity in which mediating artefacts are used, (for example the concept of mind tools, Jonassen and Reeves, 1996; Lajoie, 2000), is also important. The same mediating artefact may have different affordances when used in different contexts. Lajoie (cognitive tools) and Jonassen (Mindtools) both advocate using commonly available business applications such as spreadsheets, word processors and databases for educational purposes as long as the nature of the activity involves the learner manipulating and processing the content. Finally many mediating artefacts are often used in innovative ways (Conole and Dyke, 2004 a) and in contexts for which they were never originally designed. This leads to a dynamic process of appropriation and redesign of mediating artefacts that has been described as ‘speed of change’ in the Conole and Dyke list

of affordances. More interesting than the speed of change of mediating artefacts may be to trace the nature, or trajectory, of change in a mediating artefact as it is used in new contexts.

ICT is a uniquely flexible form of mediating artefact in that it can serve as a representational medium, can facilitate communications and carryout many forms of manipulation of information that have traditionally been the sole province of individual human cognitions. The rapid introduction of ICT to educational practice, particularly those ICT developed in other contexts such as business, has lead to many unintended and often counter productive outcomes. In order to integrate ICT effectively into educational practice we need to have a good understanding of the cognitive impact of these mediating artefacts.

Evaluating ICT in education

Boyle and Cook suggest that:

> *What is required in all approaches is serious attempts to include new empirical observations of learning in the evolution of new frameworks, tools and systems to support (i) tutors as they make decisions about the use of new technology, (ii) learners as they learn, and (iii) systems designers and developers as they envisage new innovative tools to support learning. (Boyle and Cook, 2004: p 299)*

Table 1 depicts a method for evaluating the cognitive impact of ICT in education with reference to basic target cognitive processes (1) required for learning. For each ICT identified as a mediating artefact, an analysis can be conducted into it's original affordances (4), it's original context of use (5), the types of learning activities in which it is used (6), and the rate of change in it's use (7). This may produce an understanding of the positive effects of the ICT under consideration. The table allows the user to evaluate the negative impacts of ICT, which may be the unintended consequences (9) of the adoption of ICT developed in other contexts to educational contexts. The table may also be used to suggest innovations (10 and 11) to existing ICT in order to better promote target cognitive processes. This paper is aimed at i) *educational practitioners* who are trying to implement ICT into educational practice, and ii) the *designers of systems* to support educational practitioners implementing ICT solutions and the associate pedagogy. In addressing these two groups a rationale is provided for the structure of the table. The top section relates to the cognitions of the learners and the bottom section relates to the cognitions of the designers of educational support systems. Examples of different types of ICT that could be evaluated using this system include collaborative tools, simulations, gaming systems and mobile devices. The table is intended to allow education practitioners and researchers to evaluate the effectiveness of ICT in specific educational contexts and to evaluate the effectiveness of new uses for existing ICT. For the purposes of this evaluation scheme ICT design mediating artefact, such as templates, patterns and learning management systems, are another class of mediating artefact that needs to be assessed in the same manner as other mediating artefacts, i.e. on the basis of its cognitive impact on the educator/designer rather than as simply a set of resources.

Learner Cognitive Impact / Cognitive Target			ICT Mediating Artefacts							
			Positive Characteristics				Negative Characteristics		Innovations	
Base Cognition	Base Activity	Cognitive Effects	Designed	Contexts	Activities	Rate of Change	Designed	Unintended	Technology	Methods
1	2	3	4	5	6	7	8	9	10	11
1. Accretion, Elaboration, Tuning, Restructuring, Cognitive dissonance, Internalisation, Transfer. 2. Argumentation, Application, Abstraction, Summarization, Exploration, Experimentation, Browsing, Restructuring. 3. What cognitive processes do we want learners to carry out? Desirable cognitive characteristics of these activities.			4. What was the original context of creation? What are the original affordances and constraints of the mediating artefact? 5. What affordances are created due to the use of the mediating artefact in new contexts? What pedagogical approach was used? 6. What affordances are created due to the use of the tool in new learning activities? What teaching strategies were used? 7. What is the rate of change and innovation associated with the mediating artefact? 8. What are the educational limitations of the mediating artefact due to it's design and configuration? 9. What negative impacts are due to the adoption of mediating artefact created in another context to educational tasks? 10. How can we enhance the affordances and constraints of ICT to better achieve the cognitive targets? 11. How can we use the ICT differently to better achieve the cognitive targets?							

Educator/Designer Cognitive Target			ICT Design Mediating Artefacts / Patterns / Templates / Taxonomies							
			Positive Characteristics				Negative Characteristics		Innovations	
Base Cognition	Base Activity	Cognitive Effects	Designed	Contexts	Activities	Rate of Change	Designed	Unintended	Technology	Methods
1	2	3	4	5	6	7	8	9	10	11
1. As above. 2. Selection, Application, Evaluation, Modification, Meta-cognition, Re-purposing existing technologies. 3. What cognitive processes do we want educator-designers to carry out?			4. LMS, Repositories, Taxonomies, PD activities, Templates, Learning objects 5. Tertiary, Secondary, Primary, Online Training 6, 7, 8, 9, 10 and 11. As above.							

Table 1 An Evaluation Scheme for ICT in Education

Table 1 may be used in two basic ways. In the first method an existing ICT Mediating Artefact may be selected, for example the iPod, and its affordances and constraints may be analyzed (4 to 9). This would lead to a consideration of the cognitive impact (1 to 3) of these affordances and constraints. Attempts could also be made to increase the cognitive impact of an existing ICT by innovations in the technology itself (9) or the method (10) in which it is used. In the second method a target cognitive process (1) may be selected using a specific type of learning activity (2), such as argumentation. Then an ICT may be selected that has the appropriate affordances and constraints (4 to 9) to engender the target cognitive process. An existing ICT may also be modified (9 to 10) to achieve a specific target cognitive activity. Developers of ICT Design Mediating Artefacts, such as Learning Management Systems (LMS) and Design Templates, would follow a similar process in designing mediating artefacts to guide teaching practitioners.

Example: the iPod as an educational ICT

In order to test this evaluation method we can look at a common ICT that has been gaining a lot of attention for its adoption as a learning technology (Chan et. al., 2006, guidelines for developing podcasts; Colbran and Tynan, 2006, podcasting; Duke University, 2005, a large scale evaluation of the use of iPods in a variety of content areas; Maag, 2006, podcast lecture material; Miller and Piller, 2005, dual channel audio and video content delivery), the iPod portable music and video player. Using the first method described the iPod's original designed affordance (4) include: displays video, graphics and audio; play, pause, shuffle, replay content; downloading content; good file compression; large storage capacity; mobile form factor, moderate availability; cross platform support with approximately 80% market share, time independent, i.e. content can be accessed outside class time. Designed constraints include: small screen format; complex content capture process; propriety file formats; and a restrictive interface. Common activities (6) using the iPod include the access and review lecture material that is downloaded. Some studies have suggested the creation of media for the iPod as a motivator for learning but this is not an affordance of the iPod itself but rather of the computer systems on which the actual content is developed. The rate at which the technology of the iPod is changing (7) include: a rapid introduction; new content distribution means; new recording software, eg iProf. The negative characteristics (8 and 9) of the iPod include: a small screen size and low resolution due to portable form factor; a restrictive content rights management system; few content authoring options. The main activity (2) associated with the use of the iPod in education so far has been browsing content that leads to a cognitive impact (1) of accretion and elaboration.

Using this evaluation technique it is clear that at present the cognitive effects (1 to 3) of the current use of the iPod as an ICT in education in many instances leads to learners passively absorbing content for study and review purposes. This outcome is dictated by the original affordances of the tool, as a content delivery system for media. The iPod has good affordances in terms of a large storage capacity and good audio replay facilities but has relatively poor capabilities to display graphical content. It is also clear that due to its mobile form factor learners will in some cases be reviewing content in distracting circumstances and in situations that mitigate against active processing of the content, such as taking notes, i.e. it is hard to take notes in a mobile context.

If the iPod is to be used as an ICT in education it needs to facilitate (9 and 10) more active processing and engagement with content (1 and 2). One method to do this would be to allow learners to tag important pieces of content for later review. Another important affordances would be if learners could record audio annotations or summaries onto such tags. If these affordances were implement then the easy distribution methods enabled by the iPod would allow learners to collaborate in the study process by swapping and critiquing tagged and annotated versions of resource materials. This would transform the iPod from a new content

distribution system with a mobile form factor to a true learning ICT, which encourages learners to actively engage with content. To accomplish this change would require a revision of the iPod software interface to allow tagging and tag replay modes, and the addition of a small microphone capable of recording learner comments onto tags.

Conclusions

The Conole and Dyke (2004 a and b) list of 'affordances' makes a valuable contribution to understanding the nature of ICT in educational contexts but as Boyle and Cook (2004) have pointed out the use of the concept of 'affordances' is problematic. This paper suggests that the concept of 'mediation' (Vygotsky, 1980) would be more appropriate since it allows an examination of the cognitive impact of ICT in education. The approach outlined in Table 1 for evaluating the cognitive impact of mediating artefacts allows the examination of the use of existing ICT to target specific learning activities and therefore to promote specific forms of cognitive processing by learners. This approach also allows a consideration of the unintended negative impacts of adopting ICT from other contexts. Finally it opens up a new perspective on the design of new ICT or the adaptation existing ICT for educational contexts by bridging the divide between learning theories and the affordances of ICT by using the concept of mediation. This brings into coordination the cognitive targets suggested by various learning theories and the 'mediating' role of the ICT tools that influence such cognition.

Educator/designers can also be examined from the perspective of cognitive targets in that when we develop mediating artefacts, such as LMSs, patterns, templates and taxonomies, our aim should not be to just provide a set of resources and instructions for their use but to engender a certain type of cognitive activity that will facilitate the design and implementation of appropriate and effective ICT solutions for particular learning contexts. Educator/designers need to understand the cognitive impact of the mediating artefacts they are employing. In order to put theory into practice researchers in the field of ICT in education need to have access to empirical tools to evaluate the educational effectiveness of these mediating artefacts and techniques. This will involve examining the nature of changes in learner activity and outputs that result from the introduction or modification of the mediating artefacts which learners employ. The challenge for researchers in this field is to adapt to a context in which the nature of mediating artefacts and their use is changing so rapidly.

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PART 2

Learning and Internationalism

PAPER 1097

What is this creature called educational technology? A review of and from the field

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Abstract

Drawing on what researchers and professionals in the field internationally say, this paper reviews educational technology as an emergent field. The review reveals the continuum of perspectives on what the field is, and how it is bounded or fragmented. The paper then describes two dimensions of the field: the professional and scholarly considering how the forms of knowledge differ and overlap in each domain. Then the focus shifts to the nature of the new knowledge field, the scholarly domain, listing the tensions and contradictions which exist. Finally the paper provides conceptual frameworks for distinguishing fields from one another, suggesting what these approaches might mean, especially for the scholarly field of educational technology.

Introduction

What is the nature of the field of educational technology? This paper teases out the answer to this question by drawing on what researchers and professionals in the field itself have to say. It starts by showing that although there is agreement that such a field exists, there is disagreement about its coherence. The paper then briefly describes one dimension of the field, that of a new profession. It focuses in more detail on another dimension, that of the scholarly field in the form of an emergent professional discipline.

Is the field of educational technology a recognisable creature? Certainly, educational technology is an acknowledged field around the world. It is called a young field by numerous researchers (Conole et al., 2004, De Vaney and Butler, 1996, Dueber, 2004, Jones, 2004, Luppicini, 2005) and acknowledged as a field from Portugal (Coutinho and Gomes, 2006) and Spain (Graells, 2004) to South Africa (Czerniewicz et al., 2006) and Australia (Alexander et al., 2006).

There is, however, disagreement about the extent to which the field is coherent, contained and bounded. Impressions of the field seem to lie along a continuum, ranging from a perspective on one end which considers the field to be unified with common postulates, ranging to a version of the field as one coming out of its infancy to a point of maturity where it is possible to seriously formalise it. The far end of the continuum sees it as fragmented and incoherent.

The “unity” view is framed by belief in consensus, and agreement about the nature and precepts of the field. Thus a confident statement from Dutch researchers asserts “the consensus about substantial elements of the knowledge base and about the nature of I.D [instructional design]”(Elen and Clarebout, 2001) and related views align themselves even more closely with a Kuhnian version of a field which states that “Despite occasional ambiguities, the paradigms of mature scientific communities can be determined with

relative ease" (Kuhn, 1962). The most explicit of these positions is expressed by Merril and the ID Group who insist that:

> *There is a scientific discipline of instruction and a technology of instructional design founded on this science. Like all science, the science of instruction is based on specific assumptions about the real world. The technology of instructional design is founded on scientific principles verified by empirical data. .... Instructional science is concerned with the discovery of the natural principles involved in instructional strategies; and instructional design is the use of these scientific principles to invent instructional design procedures and tools (Merrill et al., 1996).*

Another view is that the field is "growing up" and is ready to reach agreement on key elements.

An example of this process to reach agreement regarding the rules and elements of the field can be seen in a 2006 IT (Instructional Technology) Forum paper which set out to explicitly formalise and confirm key aspects of the field. The authors invited the more than 2000 members of 45 countries to "a dialogue about the specific language of instructional design and some new ideas we've developed about how to describe our field." They "propose that Instructional Theory has now reached a level of development where a common knowledge base with a consistent terminology would greatly facilitate the future development of knowledge in this important area" (Reigeluth and Carr-Chelman, 2006).

Another perspective is expressed by authors noting and decrying lack of coherence in the field. The field has been described as "amorphous" (De Vaney and Butler, 1996) and "disjointed" (Bruce and Levin, 1997). The fluidity of the field in Australia led two authors to suggest that it is hard to distinguish the field from any other related field. They said that the current enterprise has no simple nor singular parameters that distinguish it from other disciplines or fields of study (Hedberg and McNamara, 2002). Another Australian article begins with the suggestion that there is virtually no body of knowledge underpinning work in the field.

> *Despite the fact that e-learning research (variously referred to as Computer-Based Learning, interactive multimedia, online learning etc at different times) has a history of some 50 years, there is little evidence of the emergence of a "body of knowledge" to support practice in the field (Alexander et al., 2006).*

And finally, on a note of despair is the doubt that the field exists at all:

> *Given the available evidence, it unfortunately does not seem to be an overstatement to claim that professionals of all types in the field of IDT, including academics, practitioners and students, do not see the field as having a consensus definition, clear focus, distinct boundaries, established links between research and practice, or any obvious added value when compared to other fields (Bichelmeyer, 2004).*

One might have thought that location on the continuum of perspectives would be clustered by specific groupings, countries or location: this is not the case. The range of views—the differences and agreements—regarding the coherence of the field is spread across the globe.

The nature of the field

Part of the problem of reviewing the field is that it is viewed from different overlapping perspectives. The domain and the referents used are often implicit. This adds confusion in a context where new professions are coming into existence, where new fields are developing scholarly dimensions, and where scholarship itself can be portrayed in different ways.

The extent to which the scholarly and the professional overlap or are foregrounded varies from field to field, with fields such as law, medicine and agriculture defining their professional and scholarly linkages in distinct ways. In educational technology there is likely to be substantial overlap of the professional field with the scholarly field for several reasons: it is a young field; it is an applied field; and the key professional and scholarly roles may well be played by the same individuals.

Simultaneously and in overlapping ways, a new professional field is coming into being and a new knowledge field (or professional discipline) is emerging. The differentiation is not clearly demarcated because in educational technology, the scholars and professionals in the field may well be the same people[1]. A profession is associated with an occupation, and often with specific sites (such as law with the courts). What adds confusion to the emerging profession of educational technology is that the university is one of the key contexts in which that occupation is located (the others being schools, and other sites where training and education take place). It is likely that professionals are employed in universities on non-academic conditions of service, thus differentiating those working as academics in the new scholarly field is some ways, with different aspects of the work being visible or invisible, valued or ignored.

Attention is increasingly being paid to professionalisation of the field especially in the UK and the US (see for example (Beetham et al., 2001, Oliver, 2003, Richey et al., 2001, Surrey and Robinson, 2001). This work addresses matters such as competencies, job standardisation, career paths, sanctions, accountability and so on. The process of formalising job descriptions is still relatively new itself. While career paths were only mapped in 2001 in the UK (Beetham et al., 2001), the US has been setting out the competencies of the work for years, with the third edition of the key text in instructional design competencies being published in 2001 (Richey et al., 2001). The professional demarcation and the regulation of professional knowledge are key indicators of the emergence of the professional field, since professional knowledge is certified and credentialed (Weber, quoted in Macdonald 1995)

While knowledge is central in both the professional and the scholarly, its role and focus differs. Professions are knowledge based occupation described as a form of cultural work where the tasks addressed are human problems amenable to expert advice (Macdonald, 1995). Professional work is thus distinguished from other work by the fact that it is underpinned by abstract knowledge (Macdonald, 1995). In a scholarly field, knowledge-through production, synthesis and dissemination—is the *raison d'etre* with the goal or outcome being academic knowledge itself.

The kinds of knowledge valued and foregrounded in the professional and the scholarly, will both overlap and differ. Thus understanding the field requires engaging with the different forms and expressions of professional and scholarly knowledge. What do professionals in the field do and know and how do they communicate that knowledge? What are the differences between the way knowledge is experienced and expressed in scholarly and professional contexts? Writing in the field of teacher education, Hargreaves (1996) differentiates the different forms of knowledge (see table below) and lobbies for a new order where professional knowledge is regarded as a valued resource.

[1] It has been noted that the field in the UK is now reaching a second generation division of labour Conole, G. (2004) The Role of Learning of Learning Technology Practitioners and Researchers in Understanding Networked Learning *Networked Learning 2004* (Sheffield)

	Scholarly Knowledge	Professional Knowledge
Epistemology	generalised	context-specific
	codifiable	difficult to codify
	rational	also moral and emotional
	public	private or inter-personal
	written	oral
	explicit	tacit
	question-oriented	practical
	propositional in form	metaphorical, narrative in form

Table 2 Adapted from Hargreaves (1996)

The existence of substantial research over many years is testimony to the importance of tacit knowledge in professional practice[1]. In educational technology this is an important and neglected area of study in two ways, as we need to analyse both how educational technology professionals express and share their knowledge, as well as how technology mediates forms of knowledge within professional academic communities.

Rare commentary on these issues in the educational technology literature is found in Jones who draws on the work of Barley and Orr to suggest that educational technologists may draw on new knowledge but not produce it (Jones, 2004). This raises a crucial point about the relationship between research (knowledge production) and professional practice with one view in the field of educational technology decrying the lack of research and theory to inform and support practice (Alexander et al., 2006) and another concerned that "instructional design theory is not grounded in practice" (Bichelmeyer, 2004). This too raises issues worth of research attention i.e. the relationship between research and policy; and the relationship between research and professional practice.

Ironically, because the field is so new and so rapidly forming as technology shifts, the gap existing between professionals and scholars may not be as wide as in other fields such as teacher education. It is important be open to the likelihood that new knowledge may be emerging from professional fields in ways that needs to be tested by scholarly research, rather than the other way round, as is the usual assumption.

The challenge is therefore to ensure that the developing scholarly field is robust and rigorous, while maintaining the valuable linkages between the different forms of knowledge in the field as a whole. This adds unavoidable complexity to the formation of the scholarly field.

[1] Jaffer, S. (2007) Tacit Knowledge- a Literature Review (University of Cape Town). mentions an abundance of literature on the topic ranging from philosophical theorizing of the concept (Polanyi, 1958 and 1966; Ryle, 1949) to current research studies (Gamble 2004; Waagenaar 2004; Welsh and Lyons 2001).

The scholarly field

The most common way to describe a scholarly field in a higher education institution is as a discipline. A discipline has been described as

> *[…] a relatively stable and delimited field, easy to identify, has an academically and socially recognised name (eg found in library classifications) inscribed in institutions, labs universities, international journals, conferences, procedures (Bourdieu, 2004).*

and

> *The term, discipline, is usually reserved for areas of inquiry and application that have been established over time and follow established paradigms. There is likely to be a consistency in their basic beliefs, rationales and common principles that define the scope and structure of the discipline (Ely, 1999).*

Stability, recognition and boundaries are therefore generally associated with the concept of a discipline. Given that these are still so contested, it is unsurprising that educational technology seems more often referred to as a field than as a discipline.

Yet the field is also described in disciplinary terms of one kind or another. Thus, a discussion paper published on a online forum makes the case forcefully that it is a discipline and indeed a scientific one. The paper opens with the statement that, "There is a scientific discipline of instructional design" (Merrill et al., 1996). Elsewhere it is referred to as a relatively new discipline (Conole et al., 2004) or as a new "inter-discipline"(de Laat et al., 2005), multidisciplinary (Whitworth and Benson, 2004) and inter-disciplinary (Jones, 2004).

The distinctions between these terms are relevant to a framing of the field. Stathern usefully disentangles them when she defines *multi-disciplinarity* as the alignment of skills from different disciplines but *interdisciplinarity* as involving a common framework shared across disciplines to which each contributes its bit. She says that interdisciplinarity *'…is ….a tool (a means)* to address problems (Strathern, 2005).

She suggests that trans-disciplinarity involves bringing disciplines together in contexts where new approaches arise out of the interaction between them, but to a heightened degree. "The focus is on [the] context of application, and on a particular approach to *problem-solving* as one which creates its own theoretical impetus"; trans-disciplinarity requires "a common theoretical understanding" and a "mutual interpenetration of disciplinary epistemologies" (Gibbons et al., 1994: 29). Here the reach into core disciplinary practices carries the expectation of new theoretical models and new institutional forms.

By this definition, the achievement of trans-disciplinarity would mean the creation of and consensus about a new, in-depth shared paradigm for educational technology. As can be seen from this review, there is no evidence of any such consensus or such depth. Therefore the terms inter and multi disciplinarity prove more promising to describe the ways that educational technologist draw on and contribute to allied disciplinary fields. Exactly how this is manifest is worthy of research attention.

The consequences of the field being inter-disciplinary must therefore also be considered. It has been observed for example that because educational technology draws on so many disciplines, the community of educational technologists may only be familiar with "feeder disciplines", each of which has its own theoretical domain, and indeed these outlooks may be *incommensurable* (my italics) (Jones, 2004). He adds, crucially that there is no one meta-theory linking the feeder disciplines or unifying the discipline internally, confirming that the field cannot be called transdisciplinary.

Indeed, some researchers regard this ability to draw on associated disciplines as both desirable and necessary:

> *I think in general we need to break down disciplinary barriers and view ourselves as a community examining issues and learning from one another. How do we break down those barriers—what is there to learn from one another? That is the first question. Then the question is how do we promote a culture change to change the focus from "defining instructional technology" to identifying important issues to be studied. And also identifying where other work is being done on those issues—finding collaborators (Duffy, 2003).*

and

> *In reflecting on one's discipline it is important to draw on closely related and even distally related disciplines to both inspire new ideas and sharpen boundaries… A discipline that draws on its own practices as the primary inspiration of its research and theory risks stagnation and decline (Kozma, 2000).*

and

> *The discussion so far suggests that research in open and distance learning needs to be grounded in theory, that there are often benefits in drawing theory from outside narrow educational confines and that research will suffer unless this is done (Perraton, 2000).*

This approach is a problem for those who have taken a traditional empiricist view of the field, as succinctly expressed by a well known US professor:

> *Those persons who claim that knowledge is founded on collaboration rather than empirical science, or who claim that all truth is relative, are not instructional designers. They have disassociated themselves from the technology of instructional design. We don't want to cast anyone out of the discipline of instructional science or the technology of instructional design; however, those who decry scientific method, and who deride instructional strategies, don't need to be cast off; they have exited on their own (Merrill et al., 1996).*

Although this statement may appear extreme, the aspiration for the field to be considered as a science with a single overarching paradigm as the natural sciences are believed to have, seems to be a common one. There are however, many researchers who consider the field to be a social science with all its attendant challenges:

> *The field of Educational Technology shares many of the same struggles in defining itself and substantiating its foundations, as do other social sciences and applied social sciences. (Luppicini, 2005).*

and

> *Research into e-learning brings together a broad range of social science researchers (Whitworth and Benson et al 2004).*

The issue is not yet resolved. This observation made almost two decades ago remains true today:

> *It is unsurprising that the tensions between the sciences and humanities antecedents are manifest in the field. In some circles this is expressed as a tension between what is called learning sciences or behavioural science and between physical and technological sciences (Banville and Landry, 1989).*

The tension is also expressed as a positivist/ modernist and post-modern dichotomy. On the whole the most significant cluster of approaches to scholarly work in the field internationally could be described as positivist. (This impression itself would be worth verifying.) However, there is a cluster of research examples which are based on post modernist principles and argue that post-modernist approaches provide valuable lenses to the field. (Bryson and de

Castell, 1994, De Vaney, 1998, De Vaney and Butler, 1996, Hlynka, 2003). These views argue for pluralism, criticism rather than evaluation, constant rethinking of beliefs and technology, a focus on power relationships as well as highlighting the relationship between corporate interests and technologies in the classroom (De Vaney, 1998, Hlynka and A, 1992).

As a field educational technology (often in the guise of instructional technology or instructional design) is most established in the USA where it has been observed that six studies from 1970 to 1994 have already examined its identity as a field (Carr-Chellman, 2006). The USA is the only place where books on the nature of the field have been written; interestingly those too tend to refer to the field rather than to the discipline. Interestingly, the more recent books *Instructional Technology, the Definition and the Domains of the Field* (Seels and Richey, 1994) and *Educational Technology The Development of a Concept* (Januszewski, 2001) refer predominantly to the field as professional and applied. While this might suggest that their focus is largely on professional knowledge and domains, the references to research agendas and to scholarly pursuits also suggest that the overlaps of the professional and scholarly in the US are substantial.

Differentiating knowledge fields

Academic fields or disciplines are defined partly in terms of what they are not, how they are distinguished from other fields or disciplines. Although writing about the formation of anthropology, Clifford's observations are pertinent. He notes that a discipline most actively defines itself at its edges, in reaction to what it says it is not. It does this by selectively appropriating and excluding elements that impinge, influences that must be managed, translated, incorporated. It draws lines to mark frontiers (Clifford, 2005).

Classifications may be expressed in different ways, ranging from structural to bureaucratic to theoretical.

The way the universities are structured may be crucial to the identity of the field in terms of where it is located and concomitantly where it is not located. Clifford notes that structural issues are linked to 'disciplinary patriotism' and that disciplines are sub cultures of a wider polity, in this case the university. The setting of such boundaries is not a neutral activity. Using Bourdieu as a lens to understand the scholarly field of Career, Lellatchitch et al argue that a field is a social sub system based on historically generated system of shared meaning. The boundaries of a field are where the effects of empirical research cease to have meaning, where the stakes of the game lose their impact (Lellatchitch et al., 2001).

Educational technology research, courses and new departments may be located in education departments, in computer science departments, in media studies departments. In South Africa it has been noted that they are increasingly located in higher education development structures or higher education studies (Czerniewicz et al., 2006). Given that structural location may significantly determine the influences a field is both exposed to and identified with (and thus what becomes valued), such structural decisions may have profound effects on the nature of the field in certain settings.

The way that bureaucracies are organised may also be key determinants in field formation. The classification schemes of state information systems or research body clusters may play a role in the development of a field's identity. Indeed, government and funding organisations devise systems to suit particular agendas (White and Liccardi, 2006); the location or indeed the invisibility of educational technology is these classifications is also worthy of research attention. In South Africa for example, disciplines are classified under the 2004 Classification of Educational Subject Matter (CESM) taxonomic coding scheme (Education, 2004). This organises subject matter into 22 (first order) categories and a wide variety of categories to the fourth order. State funding is partly determined by CESM classification (the Teaching Input Grid being a dimension of the funding formula), with for example the social sciences

receiving half of the funding of the physical sciences. A new Masters in Educational technology programme located in Computer Science would receive more state funding than the same programme located in Education. Thus which kind of science the field is defined as being, has profound resource implications, as well as identity implications.

The most common classification within higher education for distinguishing disciplines was developed by Biglan in 1973 (Biglan, 1973a, Biglan, 1973b) and extended and popularised by Becher and Trowler in their book *Academic Tribes and Territories* (Becher and Trowler, 2001). Biglan's original classification suggested three dichotomies, with the three continuums being: practicality (Pure/applied); paradigm development (Hard/soft); and object of study (Life/non -life).

The life/non life continuum has been dropped from the work of researchers who extended this model and fields are usually located in categories such as in the table below.

	Hard	**Soft**
Pure	e.g. chemistry	e.g. History
Applied	e.g. Engineering	e.g. Accounting

There are no examples of educational technology as a discipline having been classified using the Biglan table, an activity which would be a challenge given its nature. If the Life/Non-life continuum were to be resurrected it would also force a choice between the two key concepts as the primary object of study: education (life) or technology (non-life). Biglan has, however, been used for studies on ICTs and disciplinary differences[1]; and Biglan and Becher's frameworks have been used to classify the associated fields of computer science and information science (Clark, 2003, Webber, 2003).

Another fairly common classification scheme, Whitley's (Whitley, 1984) is also long standing and still in use today. Whitley distinguishes between fields on the basis of task certainty/ uncertainty and strategic certainty/ uncertainty. This refers to the degree of problem variability and instability which influences the conduct, co-ordination and control of research in the field. While Whitley's framework has not been used to map the field of educational technology it has been valuable in descriptions of the related field of academic development and computer science (Bath and Smith, 2004, Clark, 2006, Moses, 1990).

Finally, disciplines have been distinguished on the basis of whether they are convergent (with tightly knit and clearly defensible boundaries) or divergent (with ill defined boundaries) (Becher and Trowler, 2001), with educational technology clearly providing an example of the latter.

Field identity formation means distinguishing the field from that which it is not. The differentiation process occurs through strategic, resource and conceptual strategies and categorisation processes, none of which are neutral. While the overt boundary-setting process is still in its early stages in the educational technology field, it is evident that approaches to setting the parameters in the field are varied. The common approaches described briefly here provide pointers to an area requiring closer attention.

[1] See for example White and Liccardi White, S. and Liccardi, I. (2006) Disciplinary differences—Frameworks For Better Learning Design, *Proceedings of IEEE ICALT2006—The 6th International Conference on Advanced Learning Technology for,* (Kerkrade, The Netherlands, also Brown and Czerniewicz 2006

Conclusion

Why pay closer attention to the formation and differentiation of the field? What is the purpose of describing the way the terrain may be framed? In a context where a commitment has been made "to establish the area of learning technology as a discipline in its own right" (ALT-C Guidelines, P.1), it is important to have a sense of what the features of the terrain might be, how the map might be drawn and what the characteristics of a scholarly domain might look like. This paper has sketched the terrain as it is perceived by those working in the field internationally. While touching on the key dimension of the rise of the professional field, the focus has been on the emergence of a new knowledge field expressed in the scholarly domain. This nascent professional discipline or inter-discipline is taking undoubtedly shape, inevitably marked by the tensions and contradictions demonstrated in the paper. By showing the more common taxonomies of field differentiation, ways of distinguishing the field have been suggested.

Why does all this matter? Agreement of the key elements of the new domain, and agreement about ways of seeing will help build the internal consistency in the field. With researchers and professionals from such a wide range of backgrounds, coherent articulation and integration are necessary. While field formation cannot be prescribed, the process can be made explicit. Sufficient consensus is needed to enable communication amongst educational technology researchers and professionals, and in order to build a credible, legitimate and meaningful knowledge field.

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PAPER 1125

Collaborative knowledge building through online reflective journals: a Russian case study

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Abstract

Using the theories of Mikhail Bakhtin and the results of a three-year EU TEMPUS project (2002–5) coordinated by Manchester Metropolitan University and a follow-up ESCalate project (2005) in the Udmurt Republic, Russian Federation, this article assesses the usefulness of computer mediated communication, in particular online reflective journals as a means of encouraging collaborative knowledge building in the field of social policy in Russia. It explores the difficulties of using such a technique in Russia where academics and practitioners are unfamiliar with reflective practices and outlines the benefits of using this approach and Bakhtin's theory of speech genres in analysing how collaborative knowledge building takes place.

Introduction

The development of new computer technologies broadens opportunities for new ways of teaching and learning. Computer-mediated communication provides a shared environment for collaborative learning facilitates the process of collaboration by bringing together participants who are geographically dispersed and supports asynchronous communication between participants. At the same time new computer technologies make it possible to modernise traditional and well established methods in teaching and learning by applying them in new contexts. This article explores the use of online reflective journals as a tool for the collaborative construction of knowledge in the field of social welfare in Russia and applies Mikhail Bakhtin's theory to analyse the emerging genre of the online dialogue.

Models of collaborative knowledge building

Collaborative learning can be described as a "learning process where two or more people work together to create meaning, explore a topic, or improve skills" (Harasim, Hiltz, Teles and Turoff, 1995, p.30). This process occurs through a set of collaborative activities that enhance learning efficiency. The two dominating metaphors for learning, according to Sfard (1998), are an *acquisition metaphor*—by which learning is treated as "gaining possession over some commodity" and a *participation metaphor*—by which learning is "conceived of as a process of becoming a member of a certain community" (p. 6). The acquisition metaphor focuses predominantly on the changes happening to the learner in the process of learning, while the

participation metaphor concentrates on the changes happening in the learner's social environment. Koschmann (1999, 2001) introduced a third metaphor for learning, based on Dewley's notion of transaction (Dewley and Bentley, 1991) which sees learning as a process "that not only transforms the learner, but also the environment within which the learning occurs" (Koschmann, 1999, p. 451). This approach is based on the writings of the Russian philologist Bakhtin. The works of Bakhtin and the Bakhtin circle (Bakhtin, 1981, 1984, 1986; Volosinov, 1986) demonstrate the dialogic nature of all texts which extends to all uses of language. What we say, write or think encapsulates the voices of others. From a Bakhtinian perspective, "the ideological becoming of a human being…is the process of selectively assimilating the words of others" (Bakhtin, 1981, p. 13). The central issue is thus "who is doing the talking?" Dialogue involves a tension between *centripetal forces* which represent "authoritative" discourse and *centrifugal forces* which represent "internally-persuasive" discourse. Authoritative discourse aims to impose a particular meaning in specific socio-cultural settings. According to Bakhtin "The authoritative word demands that we acknowledge it, that we make it our own: it binds us, quite independent of any power it might have to persuade us internally: we encounter it with its authority already fused to it—it demands our unconditional allegiance" (1981, p. 343). Centrifugal forces, on the other hand, represent the "internally-persuasive discourse" that is exploring, questioning and reflecting on experience. These competing discourses are in constant dynamic conflict. Bakhtin (1986) also distinguishes between *social languages* on the basis of speakers' social groups, and *speech genres* (p. 87). Bakhtin's notion of dialogicality provides a new perspective on the learning process. Learning is seen as the process when two or more voices come into contact (Wertsch and Smolka, 1993). Social knowledge building takes place through the collaborative exchange of utterances. But how can this knowledge building process be documented? This can be done by analysing transcripts of the dialogues, generated by participants and focusing on how learners appropriate particular speech genres and how these different speech genres, in turn, allow for the expression of the multivoiced nature of learners' speeches.

In this article learning has been approached as a social process which consists of a dialectical cycle of personal and social knowledge building. Fig.1 below based on Stahl (2000) provides a representation of this cycle and defines its typical phases. Moving through the different phases of this circle—discussion, argumentation, clarification—results in the formation of shared language created through communication. The negotiated agreement of participants on common understandings, issues and conclusions results in the establishment of their shared collaborative knowledge. The new shared knowledge can be represented in publications or other cultural artefacts.

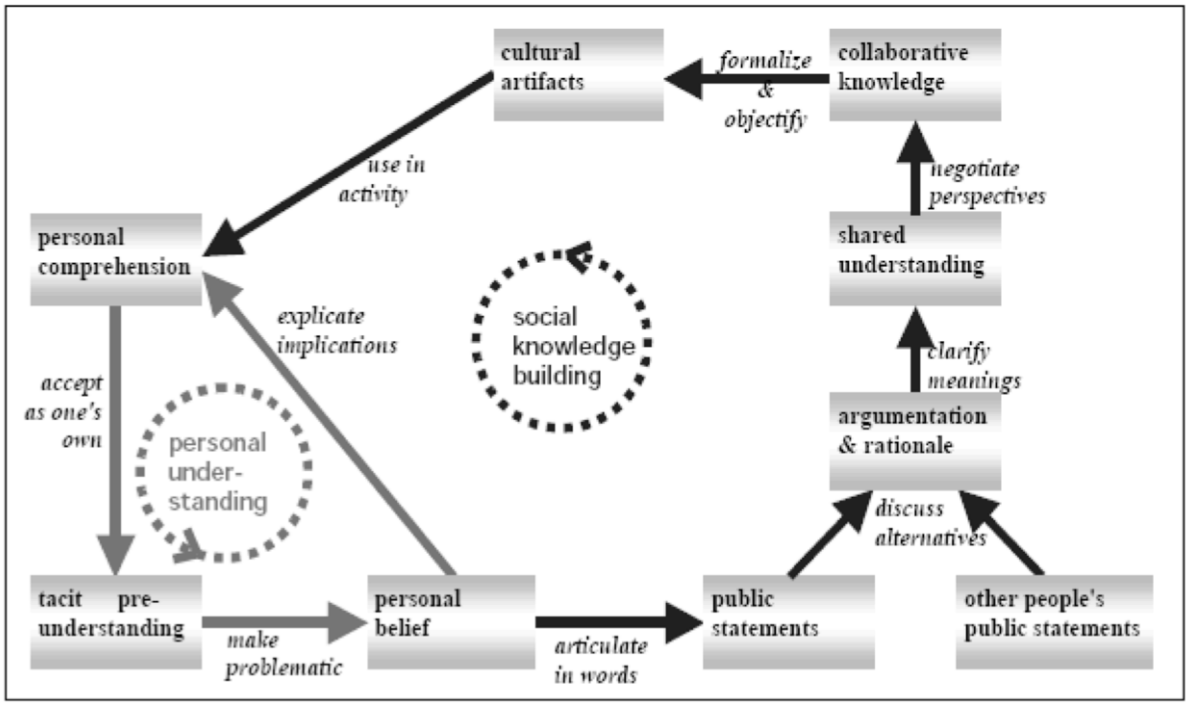

Figure 1 Collaborative knowledge building process (Stahl, 2000).

According to Stahl's concept (2000), the individual and social dialectically constitute to the learning process. It is evident that the cycle of personal understanding starts on the basis of tacit pre-understanding. Our interpretations are shaped by our culture, language, history, politics, social environment and social interactions. But at the same time, our personal perspective or voice (Bakhtin, 1981, 1984, 1986) is multivocal, populated by many perspectives or voices of others. To resolve the over-emphasis on our personal understanding we may need to create new meanings collaboratively. This article applies the model described above in the following case study to illustrate how computer-mediated communications support the prominent stages of this process and analyses the issues arising during this process. Bakhtin's approach is used to explore how collaborative learning takes place through the appropriation of new speech genres by the participants in our online asynchronous discussion and to assess the impact of socio-cultural diversity on the degree of international collaboration.

Russian case study

The results presented here are based on a project coordinated by Manchester Metropolitan University (MMU), UK and also involving University of Helsinki, Finland. This was a TEMPUS funded project and the aim was to establish 'A Centre for Social Policy at Udmurt State University', Russia and thereby encourage international professional learning and knowledge transfer among teachers and lecturers in higher education and social welfare practitioners throughout the region. Academics, practitioners and policy makers participated in a cycle of mobilities between the Russian Federation, United Kingdom and Finland (2003–2005) during which they learned how welfare systems operated in different countries, how policies were designed and implemented, what the roles of local authorities were and their relationships with local communities, how non-governmental organisations provided services, how social workers were trained, what the issues of current provision of social welfare were and how it could be improved and the prospect for its future development. The acquired knowledge allowed for the transfer and dissemination of best practice, implementation of new

approaches and the formation of new structures in the provision of Russian social services. The role of the established Centre was central to these processes. A diverse range of participants—academics, practitioners, policy makers—collaborated in identifying potential and prioritised areas where the experience gained could be put into practice. In calling for radical changes in social welfare provision, this collaboration focused upon current needs and allowed for the development of new strategies in this area. As part of this project, a group of participants were asked to contribute to online reflective journal writing. This activity was aimed at encouraging reflective and collaborative international professional development and was funded by ESCalate.

Methodology

The virtual learning environment used was Basic Support for Collaborative Learning (BSCW) that was freely available on the web. BSCW provides a flexible and user-friendly environment for building collaborative knowledge. Each participant has his/her own workspace and at the same time, a group mediator from MMU creates a shared space for collaborative activities. The mediator distributes documents and provides links to web resources, sets up and invites the participants to join in the discussion. In this way participants can see the shared folders which contain shared resources or discussions in each personal workspace. The participants used the BSCW tool to post their own journal entries and reply to the entries of other peers, comment on documents and provide reactions to current events. The email communication tool was used to correspond directly with a mediator. Entries were in both Russian and English languages. All entries were translated into both languages. This helped the participants, especially from the Russian side, to express themselves more freely and fully and at the same time to overcome language barriers.

A group of ten participants took part in this research activity. Six contributors represented academics from Udmurt State University who were involved in the EU TEMPUS project. Their main contribution to the establishment of the Centre for Social Policy was curriculum design and the development of programmes for practitioners and policy makers in the area of social policy and welfare in Udmurtia. The other four participants included three practitioners (two social workers and one psychiatrist) and a Deputy Minister in the Federal Government. Such a diverse range of contributors provided the author with an opportunity to gain insights into a cross-section of personal reflections and a fairly complete picture of the learning process. The participants were asked to keep a journal and exchange reflective writings with peers including the mediators. As this well known and well established technique was unfamiliar to Russian colleagues, they were given some advice on how to approach this task e.g. to describe their experience and focus upon significant issues in terms of decisions, successes, failures, challenges and to explore ways to resolve problems or mistakes.

Results

The participants recorded their journal entries each week for a period of several months during 2005. The accounts were immediate, not retrospective, as it was important to explore learning in process and journal entries took the form of relatively free writing rather than a formal, structured report. After the start of discussion the participants were required to post their entries, reply to the mediator's comments or comment on the opinions of their peers. The mediator had to be very skilful in their performance as it could affect the way the participants would respond. S/he observed and facilitated the discussion by encouraging dialogue and clarifying questions, stimulating participation by making remarks and providing support by sharing similar problems. The mediator focused primarily on participants collaborative learning and their own reflective and critical thinking process by taking a background role. Practically all the contributors involved pointed out in their journal entries or through the emails sent to the mediator directly that they were experiencing problems with

deciding on what to address. Even those Russian participants who were used to traditional journaling (diaries) were struggling on where to start. Some of the incidents were too insignificant in their view to discuss, or it was difficult to identify an incident to reflect upon. In their search for a starting point the participants were waiting for the mediator to direct them. The activity undertaken shows that it takes time for the participants to reflect but they also needed to learn how to write reflectively and critically. At the beginning, Russian entries lacked critical analysis and failed to assess their impact on others. The contributors insisted on a precise indication of what the mediator wanted them to write.

They would take on the evaluative perspective that had been "authorised" by the mediator and apply it to their own judgements. But the intention was to focus on their choice of voices, position and evaluation and the dynamics of this process while the participants were involved in collaborative activity. Our attention was on the ways the speech genre emerged, the tension between "authoritative" and more creative internal voices and the ways that participants used the inter-textual referencing to make their judgements. That is why the mediator's instructions can be crucial.

Although access to the shared space was limited to the participating members of the project, the fact that their writings would be available to the whole group and not only the mediator, was perceived as an impediment at first not because online discussion was a new experience to them (on the contrary, a few of the group members participated in blogging before), but for fear that what they wrote didn't comply with the requirements, that the group members could identify the author and so forth.

One of the most interesting issues raised during the online discussion was the role of local communities in the provision of social services. During their mobilities to the UK and Finland, the participants in the project had the opportunity to visit the local authorities in Manchester and Helsinki and to familiarise themselves with their role in the delivery of social services in such areas as fostering, care for people with disabilities and elderly, etc. Russian colleagues were very positive in reflecting on some working practice models of such a community based social practice, and at the same time were quite critical about the current situation in Russia where such provision has not been developed, or the local communities were passive or not part of the social services provision structure. Our participants demonstrated an awareness of the constraints on local authorities in Russia and the inability of agencies to deal with social problems. Many entries revealed a strong scepticism about the possibilities of adapting the forms and structures experienced in an Udmurtian context. For example one participant noted:

> *"Another problem is the existence of a culture of dependency which plays a significant part in Russian society: even when a person can solve some of his problems himself he prefers to wait until the state will step in because the person is certain that the state owes him. The paradox is that because of this, our bureaucratic state machine only becomes stronger and even more bureaucratic." (N.)*

Other issues highlighted included a shortage of Russian and translated western literature on social policy, both in terms of text books and research, a lack of theory underpinning traditional Russian approaches to social work teaching and practice and the role of the embryonic voluntary sector in the delivery of social services in Udmurtia. An equally dominant theme concerned the innovative powers of social policy practitioners in Udmurtia who had ironically found the "space" to operate in areas such as mental health care or drug abuse where the state had withdrawn completely.

In discussing these issues a conflict between centripetal and centrifugal forces and between authoritative and internally-persuasive discourses was evident. The participants sought an "authoritative voice" to use for writing their journal entries. In their understanding the critical reflection should bear this authoritative angle to it and in this sense it was the required one. In

their search for this authority they looked to the mediator to provide them with the "right" perspective. Hulme (2005) attributes this to the culture of Russian public sector organisations and the inherited need to adopt the "given" authoritative voice in all "formal" forms of written communication. "Tell me what to write" was the most common question.

As our discussion unfolded so did the learning process. A few of participants became more confident in their own critical analysis and as a result their writings became more free from the dominant authoritative voice. Russian participants learned how to reflect and were more active in commenting on the entries of the others. The language of writings moved to the form of internally-persuasive discourse. However, some of the participants were more reluctant to make open critical reflections or comments and preferred instead to send emails which were not accessible to the rest of the group directly to the mediator to adopt an "authoritative" opinion or to keep their involvement to the minimum.

The construction of such a dialogue, the exchange of opinions and the development of critical thought revealed that further progress in building collaborative knowledge required mediation of the language of academic discourse. A good example was the notion of "social policy" and how it is perceived in Russia and the UK. One Russian participant noted that

> *"in Soviet times social policy was solely perceived of as one of the aspects of governmental activity…and often did not include culture, ecology, housing, health care or education. …the notion of 'social policy' was narrowed down to 'social security' (pension, support to those with disabilities etc.) Such a perception of social policy can still be found today." (M.)*

Our online dialogue highlighted this issue of clarification of terminology as central to the success of the whole process. It is the area where historical, political or cultural diversity needs to be addressed because if we assume the same terms have the same meaning in different contexts then this might lead to misunderstanding and confusion. It was also pointed out that the lack of adequate terminology can influence outcomes when participants where disseminating gained knowledge through workshops or talks. In the following section this article draws on examples from the journal entries to provide evidence on the benefits and drawbacks of collaborative knowledge building.

Evolving speech genres

The use of computer-mediated communication provides ways for new forms of discourse to develop. These emerging speech genres appear as a response to a new type of social communication which uses written language. The use of online journals for collaborative activities stimulates a text based communication which in many ways is reminiscent of a face-to-face conversation in terms of quick response, interactivity and informal tone. Although this type of communication lacks the visual and audio impact of actual face-to-face communication and participants are not present in the same place, this can be overcome by indicating an emotional tone or by quoting or referring to someone's particular expressions etc. The genres which evolve in this computer-mediated social environment reflect the purpose of the environment used for this communication, in our case the use of VLE. In analysing the posted entries, the author bore in mind Bakhtin's perspective that "every utterance must be regarded primarily as a response to the preceding utterances of the given sphere…" (Bakhtin, 1986, p. 91), focused on the evolution of the genre which was appropriated by our community of learners and looked at the tension between authoritative and internally persuasive discourses, multivoicedness and meaning of the texts and what audience they addressed.

At the beginning, the entries represented an example of a report writing genre and reflected a formal academic voice which was hardly surprising as this is a well established technique in academic circles and the newness of online journaling activity also reinforced this trend. This

report writing genre leaves less room from creativity, is more rigid and as a consequence is more "safe" to use. It is an example of "authoritative" discourse. This genre did not work well and so participants explored other ways of interacting with the audience via the introduction of the dialogic mode. As a result, the tone of writing became more personal and less authoritative. The following examples show the multilevel addressivity evident in the extracts. In the first instance, participants address their colleagues while at the same time sharing their critical views of the current situation with welfare provision in Russia, and at a deeper level criticising the policy makers who allow this situation to happen. Thus one stated

> *"In my opinion, we can't talk about multi-agency activity at a republican level in contemporary Russia. Business behaves as a predator –it shifts all social problems onto the state and at the same time escapes paying taxes in full. Private capital does not often provide social security for its employees in full (wages are not paid regularly and in full, paid leave in the private sector is more of an exception even if they are a norm according to the Labour Code)" (N.)*

and another responded

> *"Well,.. I agree… in my opinion, public organizations play a very modest and virtually non-existent role. Public organizations in Russia today, as Lenin said, are 'a great national zero'. There are plenty of them but in reality only a few are active, the level of their involvement in the social problem solving and their effectiveness varies." (P.)*

From the above we can see that the evolving genre has appropriated a dialogic nature of discussion. The responses of the participants show a frustration with the fact that the polyvocality of the western pluralism and democracy is not present in contemporary Russia.

From this analysis of the texts it is evident that the process of meaning construction still bears the stamp of the inherited Soviet times feature by being more collectivist oriented and approved by authority rather than being produced individually. This historical, cultural and institutional context influenced the way in which the discussion evolved. Russian participants were cautious in expressing their individual opinion in the presence of the authority showing their subordination to the authoritative voice. This is in turn raises the question "who owns the meaning?" (Holquist, 1990).

This analysis of the journal entries shows that the use of the scientific language related to the social sciences and the associated science speech genre by some of the participants caused some problems amongst other colleagues. The practitioners, policy makers and some academics were unable to participate in the discussion of theoretical questions due to lack of knowledge in this field. This explains the fact that some of the proposed topics for discussion were not taken further. To take an example:

> *"N,..it is of particular interest that you highlight the different conceptions of social policy in Russia and Britain. This is a theme in which I have a personal interest. I noticed…that the academic social policy work taking place in Russia tends to have a strong historical tradition; it seems to develop from a tradition of empiricism. Social Policy in the UK has developed from a more sociological tradition and is founded on theoretical perspectives such as academic Marxism, functionalism, post-modernism. Perhaps you could comment on this?" (R.)*

Russian participants agreed that knowledge of theory would be of benefit to the all parties participating in social welfare provision and training.

In this study the focus was not only on a textual analysis of the online journals but also on the knowledge building process which occurred through the use of written language. The critical evaluation of experiences gained and the resulting practices were an integral part of this process. Analysing the texts the author discovered that the focus of these dialogues seemed to be on the present. In the process of constructing their evaluation of the present, the

participants referred to the past and also evoked links to the different social contexts. From the analysis of these references it is clear that in search for the authority, established rules or recognised opinions the participants invoked particular voices in their writings. If we ask Bakhtin's question "Who is doing the talking?", the answers to it are not always obvious and straightforward. At a simple level, it is the person making the online contribution but deep down it is possible to also hear the voices of the others that populate the utterances of the participants, these voices are coming from the past, from the participants' cultural and historical heritage and their direct experience. The examples cited above show that Soviet "official science" view of social policy as well as hidden representatives from the local authorities impacted upon the way the participants made their judgements. These hierarchically structured evaluation approaches exist alongside the more dynamic and less structured evaluation framework. The latter is based on the multivoiced nature of conversation with peers, exchange of opinions and exploration of their practices. The evaluation is more immediate with appropriation or debating of the perspectives of the other colleagues, with metaphorical and ironic references.

It is interesting to notice how the contributors were using this virtual learning environment not only for discussing different issues but at the same time to maintain their social relationships. The content of our discussion was to a large extent personal. In the course of the online collaboration the participants were exchanging jokes which resulted in a less formal tone of discussion, yet it was still a serious discussion. As this discussion used both languages, English and Russian, it was always a challenge to preserve tone of a contribution in the translated version.

Overall, the proposed online activity was a useful experience. It shed light on the issues of international professional learning and allows scholars to acquire valuable qualitative data on the process of collaborative knowledge building and to assess how socio-cultural contexts influence this process.

Conclusions

This study has demonstrated the potential of using online journaling as a tool in collaborative knowledge building in an international professional learning context. Although the author has focused on only one circle of knowledge building process as proposed by Stahl (2000), the qualitative data used here will provide scholars with important knowledge and experience of how this process evolved. Using Bakhtin's theory, this article demonstrates how Russian participants in our Tempus/ESCalate projects were influenced by the socio-cultural context when participating in online text based professional dialogue. It is also evident that computer mediated communication is a useful tool for studying speech genres. In this case study, participants of the online dialogue shared their views on how they envisaged the role of the Centre for Social Policy as a professional learning resource with their focus placed on the building of social work capacity. Our online discussion provided an opportunity for the academics and practitioners to talk to each other and as a result to identify several key points for the future work of the Centre. This work will be concentrated on the development of a theoretical approach to understanding social policy and on a comparative analysis of international social policy practices. The results of this study will serve as a basis for curriculum design for the programmes offered by the Centre for Social Policy and also allow Russian participants to realise that the problem of incompatibility of western practices to Russian context partly stems from the absence of a legal framework for social work intervention.

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PART 3

Large-scale Implementation

PAPER 1072

Accommodating multiple learning styles and abilities in a large-scale online learning resource

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Abstract

This paper discusses and evaluates the technological and pedagogical implications of designing large-scale, online learning resources that can be offered to accommodate a variety of learning styles and abilities. The theory of online learning design and issues of cognitive ability are discussed, together with the concomitant issues of learning impairment and preferred learning styles. The focus of the presentation is on a live demonstration of a resource that can accommodate multiple learning styles without duplication of materials. The presentation will demonstrate the technological design and pedagogical underpinning of the resource and encourage discussion of the major issues in both domains.

Background

Introduction

This paper describes, discusses and evaluates the research and development of a large-scale, online teaching and learning resource. The project is a blend of instructional design, pedagogy, and IT systems development. Whilst the project grew from the support needs of distant students undertaking Masters level dissertations, this resource (the Research Observatory {RO}) now supports students in their research and project studies on attended, part-time and distance-learning modes of delivery across a university with a population of approximately 27,000 students. The resource consists of learning materials to support students through their research methods studies, both at undergraduate and postgraduate level. It is important to stress that it is a resource, not a course. It is most frequently used via the university's VLE to support research methods modules across the university, with tutors providing links to materials they feel are most important to their students' study. However, the resource is also openly available within and outside the university to facilitate easy access for students undertaking placements, or distant or part-time study.

The project is fundamentally about researching and developing online learning environments which offer learning support in a variety of contexts that can accommodate varying cognitive abilities and learning styles, with the minimum of material duplication. This is a particular issue when providing large-scale learning support across an institution, and beyond. Considerations of online accessibility often concentrate upon visual and auditory impairments and dyslexia. These are very important issues and it is entirely right that they should be addressed. However, taking account of the cognitive abilities and learning preferences of students can represent a

greater challenge as these styles and abilities affect every student, can be difficult to define, and can be even harder to accommodate without replicating materials.

This paper discusses the initial design of the RO, the evaluation of its metaphorical context, the research question that arose from that evaluation, the methods by which that question has been approached and the results of the research so far. We also discuss the opportunities for future work.

The design of RO version 1

The RO version 1 design applies a cartographic metaphor, i.e. a star map and stellar observatory, to assist students and teachers to locate and understand learning resources. The resources in the RO "universe" are grouped into "constellations" of inter-related materials. These materials are in the form of electronic learning objects utilising a variety of formats, including text, graphics, drag and drop and audio materials. Grouping materials into constellations acknowledges that, just as star constellations are human-defined groupings that make familiar patterns, so the connections between learning materials can be visualised as forming navigable associations.

The learning resources

All constellations comprise learning objects in three categories, although the exact mix varies depending upon the subject. The three categories are:

- Exploration—these comprise information about the topic in a variety of formats, e.g. text or narrated graphics presentations.
- Engagement—these comprise exercises to promote understanding, including interaction with the on-screen material in exercises such as drag and drop, self assessment questions and games.
- Application—these prompt students to consider how the knowledge they have gained can be applied to their own cognate discipline.

The learning content for the RO is provided by academic colleagues in the university who are keen to find a method of sharing their materials in electronic form. The e-learning team then converts the provided content into learning objects and adds appropriate interaction. Authors are consulted throughout this process, and if they are happy with the final rendition of their content in the test environment, it is added to the live site.

The structure of RO version 1 has been developed as a traditional, linear website that renders HTML (HyperText Markup Language) pages and interactive media to the learner. The learner has some control over the way in which this material is rendered, but only relating to text size and contrast colour via cascading style sheets. The observatory metaphor drives the context and appearance of the site, although the individual learning objects are written independent of any context. The site can be navigated in a more linear format by using the left hand navigation panel, but the terminology of the site is only expressed using the observatory metaphor; see Figure 1 below.

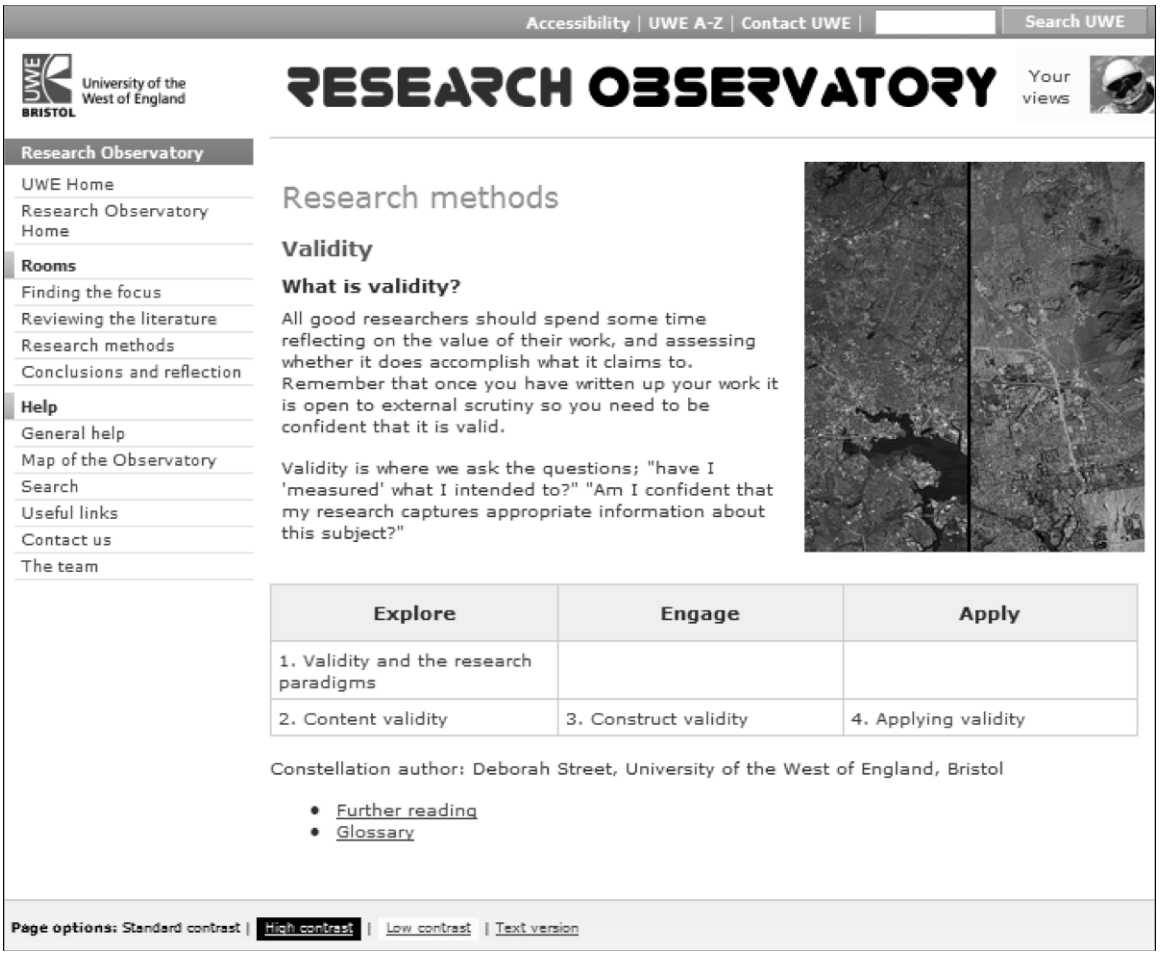

Figure 1 Example of the RO version 1

We piloted the RO with a number of students on different courses with different modes of attendance, in order to evaluate the metaphorical approach. We also recognised that metaphor might pose specific problems for learners with impairments such as Autism Spectrum Disorder (ASD), and others without diagnosed learning impairments but who demonstrate systemized learning styles and world views. These issues are much further expanded later in this paper.

The research question

The RO project is intended to begin answering the following research question.

> *What are the technological and pedagogical implications for designing online learning resources that can be offered to accommodate a variety of learning styles and abilities?*

Therefore, we next discuss the theory of content/context differentiation in online learning design, some of the underpinning theory regarding metaphoric approaches and the concomitant issues of learning impairment and learning preferences.

Theory

E-learning materials can be described in two categories, viz:

- non-specific, reusable learning objects that can be repurposed, and
- contextual materials that relate to the precise meaning for groups or individual students.

The concept of the distinction between content and context in learning environment design has been recognised for some time (see, for example, Choi and Hannafin, 1995). Weller et al (2003) describe this distinction using the terms "learning objects", which contain the core learning material or content, and "narrative objects", which deliver the contextual, sense-making narrative. This distinction was a founding principle for the design of RO version 1 which consists of both learning and narrative objects. The term "learning object" is now widely and commonly used, but it is helpful to discuss briefly at this point what we mean by the term. It has been variously defined, with Polsani (2003) commenting that there are as many definitions of learning objects as there are users. Whilst Wiley (2002) states that a learning object is "…*any digital resource that can be reused to support learning*", Polsani (*op cit*.) argues that "*A media asset or a digital object can become a LO only when it is incorporated into a form and provides a relation to itself as LO (sic) in order to facilitate the understanding of that object.*" Also, a learning object should fulfil the three functional requirements of accessibility, reusability and interoperability. However, this field is moving rapidly, and more recent work is beginning to stress more holistic approaches to learning object design that give the learner more context, narrative and rationale incorporated in the learning object, to counter the criticism that learning objects create overly "chunked" courses that may cause the learner to lose focus (see, for example, Mason 2006). Indeed, the new term of "learning component" is beginning to appear in the literature (Kaczmarek and Landowska 2007), which refers to the addition of an interface to learning objects to create unified and platform independent access.

For the purposes of the RO, we use basic learning objects (as defined above) as the finest grain elements. These learning objects are grouped into constellations introduced by one narrative object. Constellations are grouped into rooms, again introduced by one narrative object. The drawback of the flat HTML architecture of RO version 1 is that it restricts the reusability of learning objects; the same object cannot be rendered correctly from two different rooms. Early scoping defined the need for an information architecture that could hold one instance of a learning or narrative object that could be rendered in different constellations and rooms respectively.

The RO was initially developed using a map metaphor as the contextual environment, as there is significant evidence of the power of metaphor in discovering and engaging with information. In particular, there is evidence that spatial and cartographic metaphors may be especially effective. For example, Skupin (2000) argues that

> *"By virtue of their spacio-cognitive abilities, humans are able to navigate through geographical space …… those cognitive skills also have value in the exploration and analysis of non-geographic information."*

This navigational ability can also help us to see connections between apparently unrelated cognate disciplines; an important feature of high-level learning. Although disciplines may not be related by topic, they could be represented as being related spatially. For instance, fuzzy logic is a branch of mathematics, but the concepts that it includes are drawn from, and can likewise inform, human decision-making. In a spatial sense, the cognate disciplines of fuzzy logic and human decision-making occupy closely related space (Falconer, 2001), whereas in topic terms the relationship between those disciplines would not be close; fuzzy logic would be part of a mathematics discipline and decision-making would be part of a sociological discipline.

Whilst it therefore appears that metaphors may have significant promise in the design of e-learning resources, we must recognize that navigating electronic environments can pose significant difficulties for some people who suffer from cognitive impairments. In the case of online learning environments, this can result in exclusion from learning for certain communities of users where the environment does not accommodate their learning capabilities. Specifically, the understanding of metaphor is severely impaired in individuals

with certain cognitive disorders such as autism, Asperger syndrome and high functioning autism. These impairments are collectively referred to as Autism Spectrum Disorder (ASD), recognizing that sufferers can exhibit a range of symptoms depending upon the severity of the disability, i.e. the characteristic “triad of impairments” to their social interaction, communication and imagination (National Autistic Society, 2005). As such, individuals with ASD face particular issues in navigating online environments that require the synthesis of ideas and concepts together with the physical manifestation of the environment.

Evidence from studies such as that carried out by Baron-Cohen et al (2001) demonstrates that a significant proportion of neurotypical adults may have characteristics associated with the autistic spectrum, such as an accentuated tendency to categorize and systemize, together with reduced empathy. In that study, researchers developed and tested an instrument to test this in the general population; the Autism Spectrum Quotient (AQ). The AQ was applied to a group of eight hundred and forty Cambridge University students and a number of control groups. Their findings showed, *inter alia*, that amongst the Cambridge students, scientists and mathematicians scored significantly higher (i.e. further towards the autistic end of the neurotypical spectrum) than the humanities and social sciences students, supporting earlier studies that appear to correlate autistic conditions with scientific skills. So, it appears that autistic propensities are not confined to those people with diagnosed ASD. This is an important but under-recognized issue in the design of technology enhanced learning, as autistic tendencies are not recognized as a learning style or preference.

Method

This project combines the research and development disciplines of pedagogy and IT systems design, as reflected in the research question. The methods used therefore draw on both educational and systems design methodologies.

The method for the study consisted of three parts, viz:

- evaluating the metaphorical approach and general design features of RO version 1,
- researching and evaluating appropriate technological solutions to the issues raised from that evaluation, and
- developing version 2 of the RO in a revised format.

These three parts of the method are expanded below.

Initial evaluation of RO version 1

Version 1 of the RO was piloted with

- A group of forty-one distance learning MSc students in Construction Management,
- four individuals studying for PhDs in mathematics and physics, and
- a cohort of one hundred and seventy-two Computing and IT MSc dissertation students who used the RO as a resource to support a compulsory, core module in research methods.

Evaluation of the most appropriate technology to deliver the required design

This part of the project was undertaken by a Software Engineering MSc student as the research element of his studies, leading to the completion of a dissertation. The study method consisted of an initial qualitative phase, gathering the requirements and aspirations from the RO project team. Also, understanding the nature of the project in the wider ICT and learning perspective was vital, and this was partly achieved by literature review and partly by interview. The second phase was a familiarisation and assessment of the current technologies supported

by IT Services in the university, as any solution must be sustainable in the current IT environment. This was achieved by interview and observation. Thirdly, a comparative assessment was carried out by coding trials, to identify the most appropriate solution.

Development of RO version 2 prototype.

To accommodate the fact that the precise shape of the RO version 2 could not be totally foreseen by the project team, a method was needed that would enable fluid and active collaboration. We applied the Dynamic Systems Design Method (DSDM Consortium, 2002) as the project perfectly fitted the description below.

> *"A commonly recurring problem in IT systems development is the inability of both user and developer to envision a full set of requirements at the outset of a project. DSDM is predicated on the belief that nothing is built perfectly first time, and that development must proceed both iteratively and incrementally, enabling stakeholders' views to convergence [sic] towards a solution that is fit for business purpose." (ibid p.2)*

DSDM is founded on nine principles which stress active user involvement and decision-making, iterative and incremental development, the ability to reverse changes during the design process and a collaborative approach. The sense of convergence was particularly relevant to this project, as the team consists of members with a range of skills and professional backgrounds. We also felt that it was paramount that the pedagogic considerations should drive the technical design and therefore the instructional designers must play a key role in the project. So, the team worked in close proximity with continuous discussion and feedback. This meant a heavy demand on time, but the overall productivity of the project was very efficient, as in a block of seven weeks the entire RO version 2 was completed from scoping to testing.

Contribution

The findings of the project are discussed in this section.

Evaluation of RO version 1

The first pilot with students on the Construction Management MSc research methods module began with an attended session at their research methods study school. The RO design and the method of navigation were explained to the participants, who then had a one hour session using the RO and recording their views on its usability, content and relevance. These views were qualitative under the three headings and did not use any scaling system. The responses were collected during the session and analysed using a qualitative techniques. Generally the RO was well-received and the metaphoric design and navigation was appreciated and felt to be helpful by the majority of students. However, whilst there were no reported problems in navigating the RO, in a minority of responses there were some reservations about the usefulness of metaphor generally, in so far as it was not felt to be relevant to the study of research methods. These reservations were amplified by the PhD students discussed next.

The mathematics and physics PhD students' response to the RO was generally positive as a resource to support their research, but they did not see the significance of the metaphor, preferring to be *"… given the files."* One of the respondents felt that metaphor could be patronising, as it gave the impression that the user could not follow the learning materials without them being "simplified" by the metaphor. However, this group of students did not have any face to face introduction or explanation of the RO and as such their responses are not necessarily directly comparable with the Construction Management students. But, it is

clear that the metaphorical navigation of the RO did not appear relevant to them and was considered somewhat of a distraction.

The Computing and IT MSc students completed monitoring and evaluation questionnaires at the end of their research methods module, and were asked to comment specifically on online support. The responses were generally favourable, with no negative remarks about the navigation or metaphoric elements of the RO. For example, one student commented that they would like to see

> *"…continued development of the Research Observatory as it gives a different perspective."*

The tutor for the module, who had contributed material for the RO, was surprised by this observation, as the subject of the material she had contributed was the same as that which she taught in class to the same group of students. However, although the subject is the same, the arrangement and context are different when presented in the RO environment, and it is interesting to see that this is recognised by the students.

The following quotation was unsolicited on our behalf, but came to our attention during web research exercises. It comes from "A Learner's Blog" (2006) which is from a secondary school ICT teacher in the UK undertaking a PhD in the potential impact of the signs, symbols and actions of technology on learning.

> *"What I like about the site is the way that it is set up both hierarchically and visually. I like the visual metaphors and seem to be able to work much better with these than with the traditional linear structures. At the same time the linear structures are more useful for follow-up reading. The visuals give me the big picture in a way and allow me to generate my own "frame" … so it's like the visual mapping allows me to shape my own ideas without the potential distraction of the already "framed" structures."*

In summary, the pilot of version 1 made it clear to us that the metaphorical environment did engage some learners considerably, whereas for others it was irrelevant or distracting. It also gave us the insight that students may like to switch between contexts, depending upon how they are studying at the time.

Results of research into comparative evaluation of technological solutions

This part of the project resulted in an MSc Software Engineering dissertation that made two main IT systems recommendations for the design of RO version 2.

Firstly, it was recommended that HTML would be the most appropriate native format for both the learning and narrative objects. Using XML (eXtensible Markup Language) and stylesheet transformation languages such as XSLT (eXtensible Stylesheet Language Transformations) as the format for the objects was considered and evaluated. However, using XML for objects that incorporate interactive activities such as drag and drop quizzes, embedded video and self-diagnostic exercises was found to be likely to be prohibitively complex and time-consuming. As interactivity is a feature of RO version 1 that we wish to amplify in version 2, this is an important consideration.

Secondly, it was recommended that the most appropriate structure would consist of a three-tier architecture, i.e.,

- a file store to contain the individual learning and narrative objects,
- a database to control the relationships between learning and narrative objects, constellations, rooms and overlying contexts, and
- an application layer to control the interface with the learner.

This would give us the greatest flexibility in design and functionality. Again, building a structure in XML had been considered as a possible solution, but the study showed that this would be inappropriate as it would duplicate existing technologies that offer “out of the box” database and application functionality. Also, the IT Services department of the university already supports this three-tier architecture in a number of university systems and so the RO version 2 would fit into existing support structures.

Results from development and early testing of RO version 2

A specialist software designer was recruited to the team and undertook an evaluation of the recommendation that a three-tier architecture would be most appropriate. Working closely with the instructional design team members, a more detailed architecture was developed which demonstrated that the design would able to support the dynamic nature of the RO version 2 and also provide the robustness and security necessary for a resource that could be accessible to all members of the university, both on and off campus.

Support for the dynamic nature of RO version 2

The database and application incorporate features that make the use and maintenance of the RO both straightforward and flexible. In essence, the design allows any number of associations between learning and narrative objects, constellations, rooms and contexts. The default terminology for administration of the site still uses the observatory metaphor, but in the alternative literal context (the only new context currently formatted), rooms equate to topics and constellations equate to learning units. The database enables any number of learning and narrative objects to be formed into constellations, any number of constellations to be visible from any room and any context to be overlaid on the site view as a whole. These processes do not require any cookies to be set on the viewer’s computer, but are derived from the relationships in the database. For example, to add a new constellation, new learning and narrative objects are uploaded into the file store. Then, the new constellation is created by naming it and then configuring it by assigning objects from the file store. These may be new or existing objects which may or may not be members of other constellations. Finally, the constellation is made visible from one of the rooms, or a new room is created and the constellation made visible from there. New contexts are added in a similar way, by naming them and then defining which narrative objects apply to them.

Figures 2 and 3 below show the home pages of the two currently available contexts; the metaphoric and the literal. If users wish to change the context at any point in the site, they can do this by choosing the context from the drop-down box in the left hand navigation panel. They do not have to return to these front pages. The high and low contrast controls for accessibility are also available in both contexts.

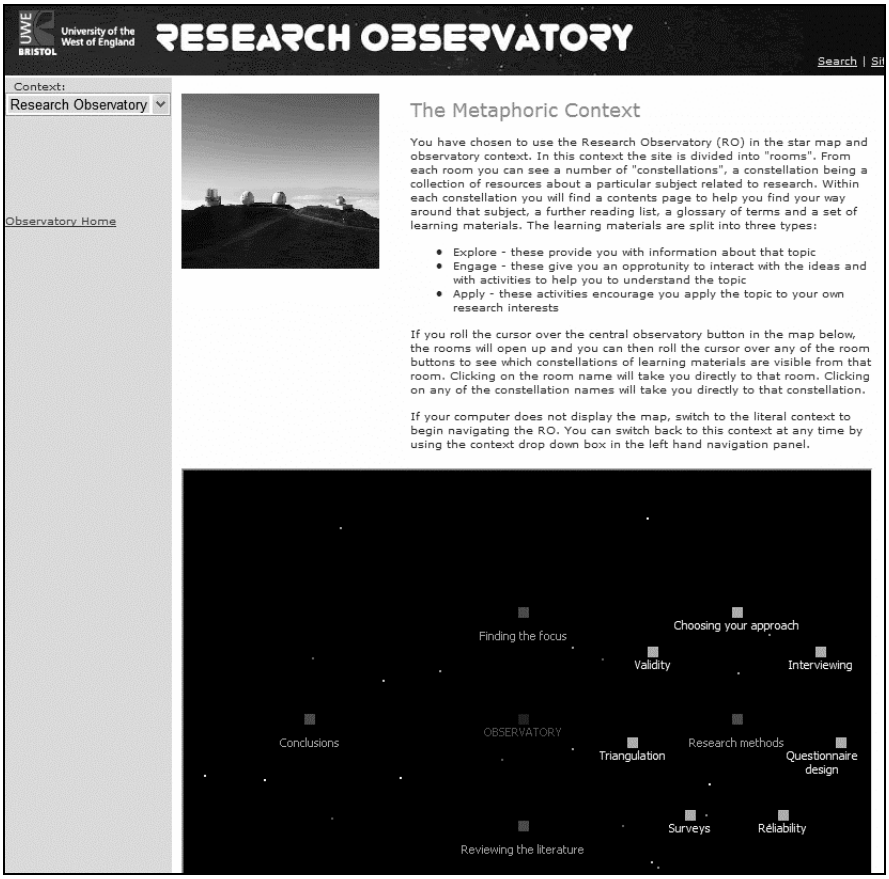

Figure 2 Example of the metaphoric context

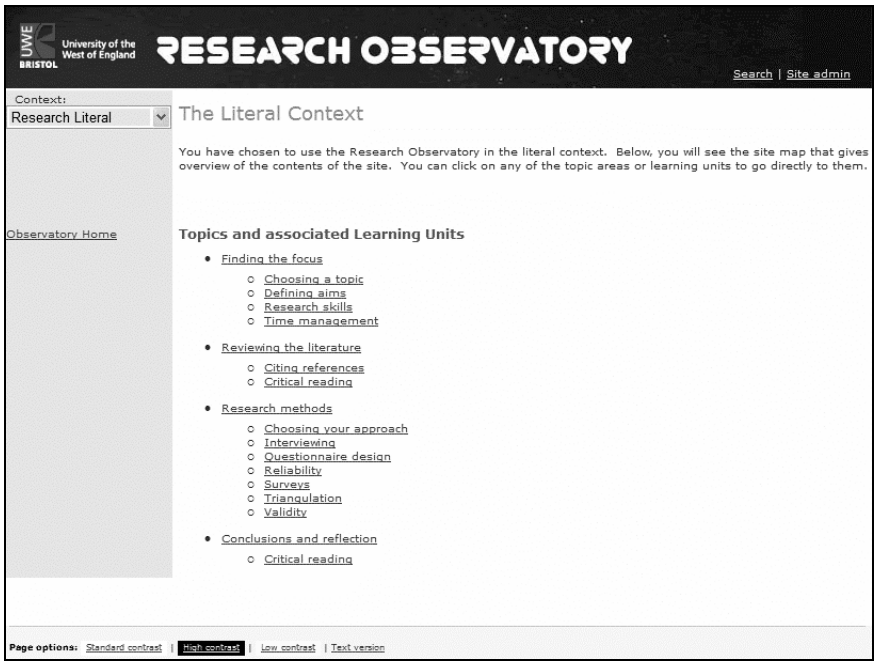

Figure 2 Example of the literal context

Security and robustness

The application front layer resides on a web server in the perimeter network or DMZ (DeMilitarized Zone) i.e. it is directly accessible from the Internet. The application drives the rendition of the RO based on the choices made by the user accessing it. The relational database resides on a consolidation database server behind the university's firewall, i.e. it is not directly accessible from the Internet. The database stores information about all the learning and narrative objects and their relationships. The file store resides on the university's Storage Area Network behind the firewall. All learning and narrative objects are physically stored there. When a user views the RO, for example a particular constellation, the application queries the database to gather the information relating to that constellation. It then accesses the related files in the file store and presents them to the user according to their chosen visual and cognitive rendition. Early testing has revealed that the architecture is both robust and secure, as at no time does any user have direct access to the database or file store.

Evaluation

In the method for evaluating the possible technical solutions, we deliberately took no prior position on preferred technologies. The only technical constraint operating on the evaluation was the ability of the university's IT services to deliver and support the chosen technology. Clearly there would be no point in recommending a technology that the institution would be unable to support. It can be argued, therefore, that it was not a totally objective evaluation in the technical sense, and we agree that this was the case. However, as this project is more research and development than pure research, these pragmatic considerations must be taken into account.

In the creation of RO version 2, we employed the DSDM approach. This has proved to be a highly effective method of design and construction, as it stresses the iterative processes of design. It fitted us as a small team, took account of the pedagogical and technical expertise of the team members and it is certainly a method we would use again in the future.

Now that we have a proven architecture, the RO version 2 forms the seed bed for further large-scale cross-curricula projects in the university. There is interest in similar resources being created in mathematics support and careers education, for example. The implemented three-tier architecture has revealed itself to be a very flexible and robust solution that could be further developed to serve an expanding set of requirements, be it new conceptual realisations of learning environments or new rendering aids. Furthermore, the team has reflected on the possibility of applying web 2.0 architecture principles to a future version 3 of the RO, with a view to devolving rendering design to the user, and thus creating a dynamic architecture that could grow organically to serve the user community's needs.

Conclusion

The project so far has clearly shown that there is a need for learning resources to be flexible enough to adapt to different learning contexts, and that current learning management systems, portals and information systems tend not to offer that degree of choice to the user. Current accessibility standards have a tendency to focus on dyslexia, hearing and vision impairments. However, it is likely that cognitive aptitudes affect a larger proportion of the student body, but of course these differences are harder to identify and harder to accommodate, particularly when presenting the same basic information or learning opportunities.

There is an interesting echo of the Baron-Cohen et al (2001) study on autistic tendencies in maths and science students and the RO version 1 evaluation relating to the views of some of the students on the irrelevance of metaphor. Our study investigated a small sample of students but the resonance suggests that future study might further explore relationships between

learning styles and subjects of study. The current phase of the research work that underpins further development of the RO is engaging with students with diagnosed ASD to collaboratively design and create further contexts that can be accommodated by the RO structure.

The development of the RO version 2 is currently ongoing. The nature of a project such as this is that there is no point at which it can be considered as 'completed'. However, the team feels that this is a good point at which to report on our findings as the development work has revealed some fundamental pedagogical issues and some technological solutions that can be used to address them.

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PART 4

Learning Technology for for the Social Network Generation

PAPER 1069

Learning and automatically assessing graph-based diagrams

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Abstract

To date there has been very little work on the machine understanding of imprecise diagrams—diagrams drawn by students in response to assessment questions. While there have successful attempts at assessing text (essays) automatically, little success with diagrams has been reported. In this paper, we explain an approach to the automatic interpretation of graph-based diagrams based on a 5-stage framework. The paper reports on some experiments in automatically grading student diagrams produced under examination conditions which show good agreement with the performance of human markers. The paper also describes how the automatic marking algorithm is being used in a variety of teaching and learning tools.

Introduction

In this paper we shall describe a number of software tools designed for learning and assessing graph-based diagrams. Typical examples are entity-relationship diagrams, UML diagrams, biological flow diagrams and chemical structure diagrams. In the work described here, we have concentrated on entity-relationship diagrams (ERDs) used in data modelling. ERDs are a simple but effective mechanism for eliciting, analysing, recording and communicating information about data that a business enterprise might store in a database. Typically, constructing ERDs is a skill normally taught in a database course but is useful in other areas such as requirements engineering.

It is common to see diagramming tools used in the teaching of ERDs, but these tend to be specifically designed to support the construction of correct diagrams by professional data modellers. In a teaching environment, we would prefer to have tools that are less constraining and which allow students to express their understanding—or lack of it—and have the tools give feedback on the errors being made. That is, the tools would deal with imprecise diagrams. Such tools would enable a student to have multiple attempts at a problem and to investigate the problem in a variety of ways. Tools that provide this kind of feedback could also grade student work and one can imagine such tools being an integral part of a computer aided assessment system, particularly if they could be applied to a wider domain than data modelling.

Our interest in assessing student attempts at drawing ERDs stemmed initially from our attempts to mark (grade) online examinations, albeit in a formative environment (Thomas et al., 2002, Thomas, 2003, 2004). Examination questions in Computing often elicit answers that include diagrams. Therefore, having a drawing tool attached to an online exam paper would be helpful. One of the advantages of an online exam is that answers are captured in electronic form and potentially can be graded automatically. While there are several systems being developed for grading textual material (Burnstein et al., 2003, Haley et al., 2005) and there is a considerable literature for describing diagrams (see, for example, (Anderson and McCartney, 2003), (Chock and Marriott, 1995), (Kniverton, 1996) and (Marriott et al, 1998)) there is very little work on grading diagrams. Tsintsfas (2002) has produced a framework for the assessment of diagram-based coursework which has fed into an ERD tool within the CourseMarker CBA system (Higgins and Bligh, 2006) and Batmaz and Hinde (2006) have investigated a semi-automatic marking system. We decided to investigate what might be possible.

In the following sections we discuss the general problem of diagram interpretation, our approach to automatically marking a diagram, and the tools we have built to exploit this technology for learning and assessment. The final section discusses how we intend to take this work forward.

Diagram interpretation

Figure 1 shows a typical ERD. It is the specimen solution to a data modelling problem and has been laid out in a form that a human marker can readily comprehend. Such a diagram is feature-based in the sense that it is composed of several types of features: boxes with names inside, lines with names beside them, circles (either open or filled) and, at the ends of some lines, ‘crowsfeet’. Each of these features has meaning within the context of an ER diagram. For example, a box represents an entity type in which the name serves to label the type of entity being described. A line with a crowsfoot at one end represents a one-to-many relationship between the entity types at either end of the line. However, some features, if they were to appear on their own would not convey meaning. An open circle on its own is still an open circle but carries no meaning in the context of an ERD, but if it appears at the end of a line joining two entity types, it represents an optional participation. It turns out to be useful to identify diagram features (or small combinations of features) that can appear on their own and carry meaning. In an ERD, there are three such structures: an individual named box represents an entity type, a named line joining two entity types represents a relationship in which the name labels the type of relationship, and a box wholly containing another box represents a supertype-subtype relationship (an example can be found in Figure 5). We refer to instances of these three structures as minimal meaningful units (MMUs) because, if any feature of the structure is removed, it ceases to convey meaning in this domain. Generally speaking, MMUs can be aggregated to form larger structures with more meaning. But since these diagrams are no longer minimal they are called meaningful units (MUs). Thus, the diagram in Figure 1 is an MU, and it contains 6 entity type MMUs and 7 relationship MMUs.

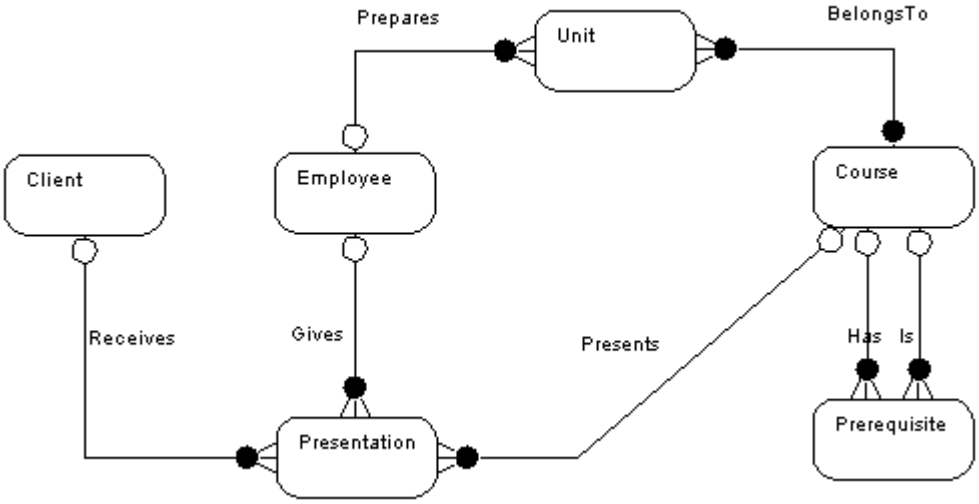

Figure 1 An entity-relationship diagram

In the domain of data modelling, there are certain small diagrams (MUs) that have useful properties. For example, Figure 2 illustrates an equivalence between two MUs. The MU at the top consists of two one-to-many relationships with specific participations. This aggregate MU can be interpreted—in this domain—as equivalent to the MU (actually an MMU) shown below it.

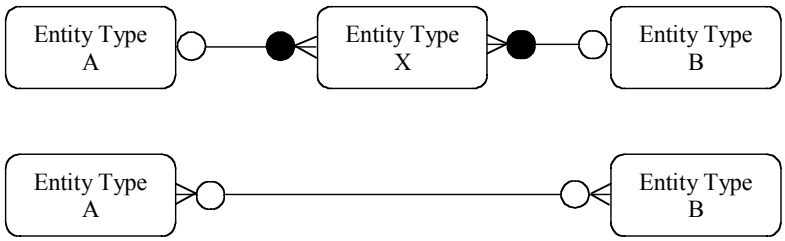

Figure 2 Equivalent MUs

However, in the area of assessment, imprecise diagrams frequently occur. An imprecise diagram is one where required features are either malformed or missing, or extraneous features are included (Smith et al., 2004).

These observations, among others, have led us to the five stage framework for interpreting imprecise diagrams shown in Figure 3.

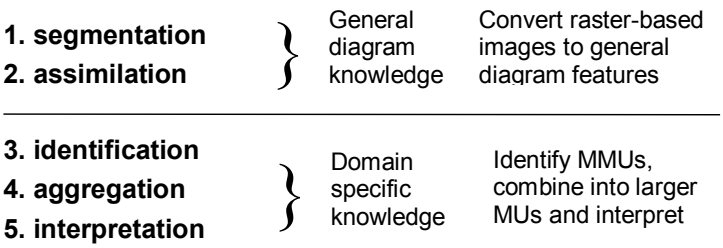

Figure 3 The 5-stage framework for imprecise diagram interpretation

The first two stages, segmentation and assimilation, use general diagram knowledge to identify basic segments such as lines and arcs to produce features such as boxes and

circles. However, our primary interest is in stages 3 to 5 where domain specific knowledge is required to interpret the diagram. The identification stage takes the diagram features from stage 2 and identifies MMUs. The aggregation phase combines MMUs to form useful MUs, and finally stage 5 takes the collection of MUs and interprets their meaning. In the work reported here, we say that we have successfully interpreted a diagram when we have successfully graded the diagram and provided meaningful feedback.

Automatic marking

Similarity measures

Figure 4 shows an example of an ERD which was drawn by a student in answer to a problem to which Figure 1 is the specimen solution. There are clear similarities between the two diagrams, but there are also some differences. In our environment, the assimilation stage is performed by a drawing tool which allows students to create boxes, lines, circles and so on to produce a diagram that purports to be an ER diagram. The identification stage converts the diagram features into MMUs. In the case of Figure 4, 6 entity types and 5 relationships can be identified.

The interpretation stage compares the student answer diagram with the specimen solution diagram by comparing the sets of MMUs in the two diagrams. (Our current automatic marker does not include an aggregation stage, although one is needed as we discuss later.) Thus, the entity types in the student diagram are compared with the entity types in the specimen solution and, likewise, the two sets of relationships are compared. The aim of the comparisons is to determine the best possible match between the MMUs in the student answer diagram and the same types of MMU in the specimen solution.

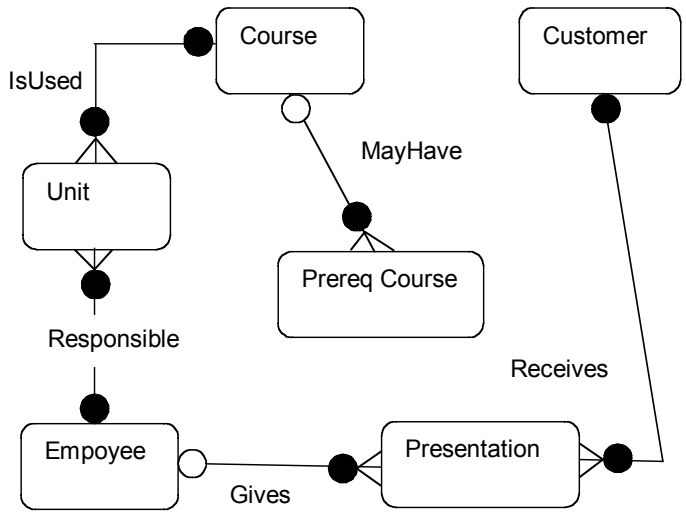

Figure 4 A student drawn ERD

The comparison is performed using similarity measures. That is, each MMU of a given type in one diagram is compared with every MMU of the same type in the other diagram and each time a measure of their similarity is computed. A similarity measure is a real number in the range [0..1] with 1 representing an exact match. The aim is to find the best possible match between the two diagrams by maximising the sum of the similarities for each MMU.

The advantage of computing a numeric similarity measure is that it enables the graceful handling of imprecision in a student's diagram. For example, when comparing the names of

entity types and relationships, we use edit distance between the names as the basis of the similarity measure. This simple scheme has the advantage that simple spelling errors can be taken into account ('Empoyee' is very similar to 'Employee'). However, the simple scheme really only works well when the student uses simple names that are close to those used in the specimen solution. Dealing with more complex naming requires synonyms to be handled effectively. In addition, the names assigned to entity and relationship types tend to be 'composite'—formed from several words—to provide slightly more meaning that would be conveyed by a single word. For example, 'Prereq Course', 'IsUsed' and 'MayHave' in Figure 4.

Therefore, we have modelled entity names as noun phrases and relationship names as verb phrases. The subsequent processing attempts to extract the noun from the noun phrase and the verb from the verb phrase and bases the similarity of names primarily (but not exclusively) on the nouns and verbs. (Stop words are discarded.)

Some further processing attempts to deal with abbreviations, which are common in this area especially when students are under time pressure as in an examination. Hyphenation that does not follow normal conventions is also popular! The final form of a name is a list of words each one of which is stemmed to deal with differences in parts of speech (receives, received and receiving would all be considered synonymous).

Since an aim of our research is to produce usable systems that can be incorporated into teaching and learning tools which execute on typical PCs with reasonable response, we have to balance the extent of the natural language processing with performance.

Synonyms

Of particular importance in accurate automatic marking is the detection of synonyms. Synonyms in every-day speech can be dealt with by conventional look-up techniques, and there are likely to be well-known domain specific synonyms, that can be handled similarly. However, it is possible to detect other names used synonymously. For example, the name 'Prereq Course' is an example of a hyponym. If the specimen solution used the word 'Course', then 'Prereq Course' can be assumed to be a synonym because it is a type of 'Course'. This would mean, in Figure 4, that 'Prereq Course' would be considered to be similar to 'Course' and also similar to 'Prerequisite'. This is not necessarily a problem provided that the similarities of 'Prereq Course' and 'Prerequisite' to 'Course' are less than 1 to allow the similarity of the occurrence of 'Course' in both diagrams to be bigger, at precisely 1. Recall that the aim is to determine the best *overall* match between the MMUs of the two diagrams; therefore, provided the matching of words that might possibly be similar does not interfere with the matching of truly synonymous words, the scheme works well.

Another, domain-specific, source of possible synonymy is where there is a one-to-one relationship between two entity types and one of those entity types is not related to any other entity type. In this case, the two entity type labels can be viewed as synonyms.

Such rules have to be applied carefully. In diagrams where supertype-subtype relationships are present, hyponymy is to be expected and it is necessary to match supertype with supertype and subtype with subtype and not allow the obvious similarity between supertype and subtype to confuse the matching—the supertype name needs to be distinguishable from the subtype name.

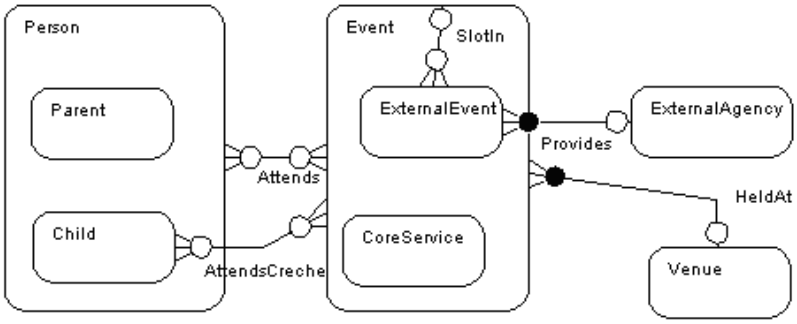

Figure 5 An ERD containing supertype-subtype relationships

The similarity measures incorporate a number of weights and thresholds. The weights are used to change the significance of diagram features to reflect their importance in different domains. The thresholds are used to avoid matching MMUs where the evidence (similarity) is limited. In some cases, the level of a threshold has been determined by experiment.

Marking schemes

Having found the best possible match between sets of MMUs, a marking scheme can be applied. In general, there can be a wide variety of marking schemes, often depending upon the concepts being assessed at a particular stage of a course. This makes marking schemes quite difficult to construct. One approach would be to provide a scripting language for specifying marking schemes but it is doubtful whether it would be used in practice. Therefore, we devised a parameterised marking algorithm which, while not comprehensive, is adequate for marking many uses of ERDs in different learning contexts.

Experimentation and results

In our early experiments with marking ERDs (Thomas et al., 2005, Waugh et al., 2004) we gained experience with relatively small sets of diagrams. These experiments gave us confidence in the approach but we required a much larger corpus of diagrams to provide more convincing evidence. Therefore, we set about constructing a sizeable corpus of student drawn ERDs. We gathered almost 600 diagrams drawn in a real, invigilated examination (the diagram shown in Figure 1 is the specimen solution to the question posed). The diagrams were graded by a group of human markers whose work was moderated (checked for consistency and accuracy by an independent marker) to provide a corpus of diagrams with marks which were felt to be accurate reflections of the diagram content.

We arbitrarily divided the corpus into two sets of diagrams. One set of almost 200 diagrams was used in the development of the marking algorithm, for detecting bugs and setting some thresholds (in NLP, such sets are often called training sets). The remaining diagrams (394) were used to test the accuracy of the automatic marker when compared to the human markers. Table 1 shows the results of this experiment. The diagrams were marked out of 7 and rounded to the nearest half mark.

Difference	0	0.5	1.0	1.5	2.0	2.5
Number	271	89	32	1	0	1
%	68.8	22.3	8.1	0.26	0	0.26
Cum. %	68.8	91.4	99.5	99.8	99.8	100

Table 1 Differences between the auto marker and humans (1)

The results show that the automatic marker agrees exactly with the human markers in almost 69% of cases. However, given the variation often present in human marking (Newstead and Dennis, 1994) we feel that the percentage of cases which differ by no more than half a mark is a better reflection of the automatic marker's accuracy: over 91% are in this category. The one outlier, which differs by 2.5 marks from the human mark, contains an error in which the student had named two entity types identically. The human marker had given 'the benefit of the doubt' and awarded credit for something the automatic marker had viewed as a significant error. Which is the better approach is a matter for debate.

This experiment, while giving an encouraging result, can be criticised on the basis that only two of the three ERD MMUs are tested. Therefore, we applied the automatic marker to a more complex ERD containing supertype-subtype relationships (again obtained from a real, invigilated examination; Figure 5 shows the specimen solution). At the time of writing we have a corpus of 30 such diagrams with moderated human marks. Table 2 shows the latest results.

Difference	0	0.5	1.0	1.5	2.0	>2.0
Number	11	18	0	1	0	0
%	36.7	60.0	0	3.3	0	0
Cum. %	36.7	96.7	96.7	100	100	100

Table 2 Differences between the auto marker and humans (2)

While the exact matches are not as good as in the first experiment, the 96.7% of cases differing by no more than 0.5 is better. However, the students' answers tended to be quite poor and so the range of human marks is much smaller than in the first experiment.

It is also interesting to compare the behaviour of the automatic marker in dealing with the two kinds of relationship. The recognition of supertype-subtype relationships (on the basis of marks awarded) is better than for ordinary relationships as shown in Table 3.

Difference	0	0.5	1.0	1.5	2.0	>2.0
Relationship	50.0	46.7	0	3.3	0	0
Supertypes	86.7	13.3	0	0	0	0

Table 3 Comparing the auto marker performance on two MMU types (%)

Armed with this information, we felt confident that the technology could be incorporated into a number of software tools to support learning and assessment, particularly in a formative environment.

Tools for learning

Revision tool

The revision tool enables a student to draw an ERD in response to a textual problem. Once satisfied with their diagram, the student requests the tool to mark the diagram and provide feedback. The user interface for the tool, after the student has drawn their diagram (top drawing) and asked to see the specimen solution (bottom drawing) is shown in Figure 6.

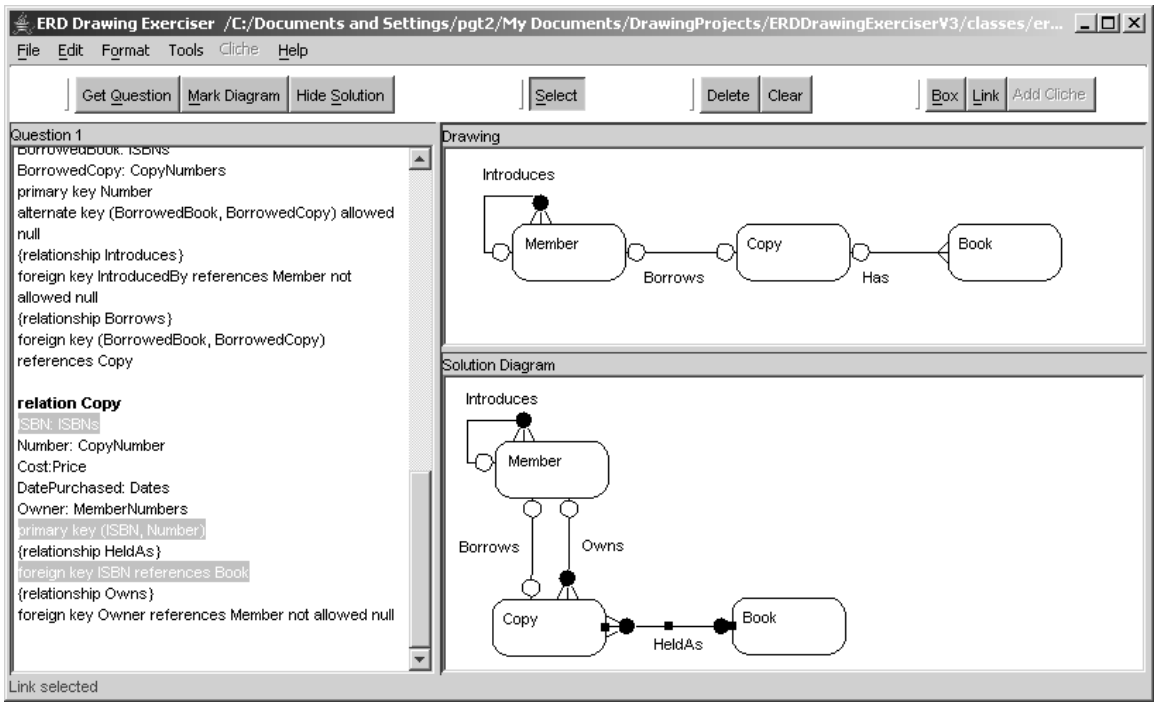

Figure 6 The revision tool

The bottom diagram, normally blanked-out, is the specimen solution whose features are all selectable. When the user selects one (the relation 'HeldAs' is shown selected), those parts of the text that relate to the feature are highlighted. The user can also right-click on a feature to obtain an explanation of how that feature relates to the problem.

When the user submits a diagram for marking, three elements of feedback are provided:

1. A grade that indicates how well the student's attempt matches the specimen solution;
2. A list of MMUs in the two diagrams showing how the automatic marker has matched those in the student diagram with those in the specimen solution;
3. A copy of the student's answer overlaying the specimen solution showing the similarities and differences between the two diagrams.

The revision tool has been tested with students and found to be a very welcome addition to our database course.

Authoring tool

The revision tool requires a considerable amount of data to be generated by the instructor including:

1 The questions (we currently provide 10);
2 Specimen solutions;
3 Descriptions of all the MMUs in each specimen solution;
4 The correspondences between the question text and the specimen solution.

To facilitate the production of this data we have built an authoring tool (see Figure 7).

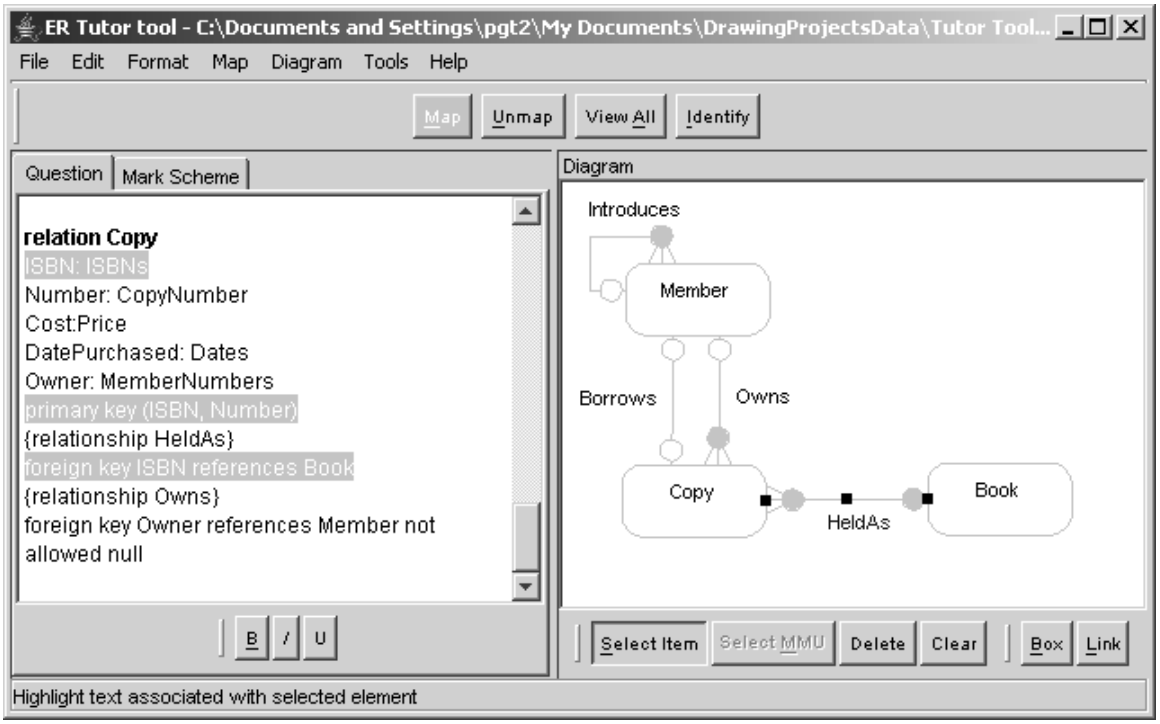

Figure 7 The authoring tool

The authoring tool has two main windows: one (on the left) for entering and editing the question text, the other (on the right) for entering and editing the specimen solution. The author can select a diagram feature (such as the 'HeldAs' relationship), highlight a section of the question text and create an association (mapping) between them (using the 'Map' button). Right-clicking on a diagram feature reveals a template for describing the feature.

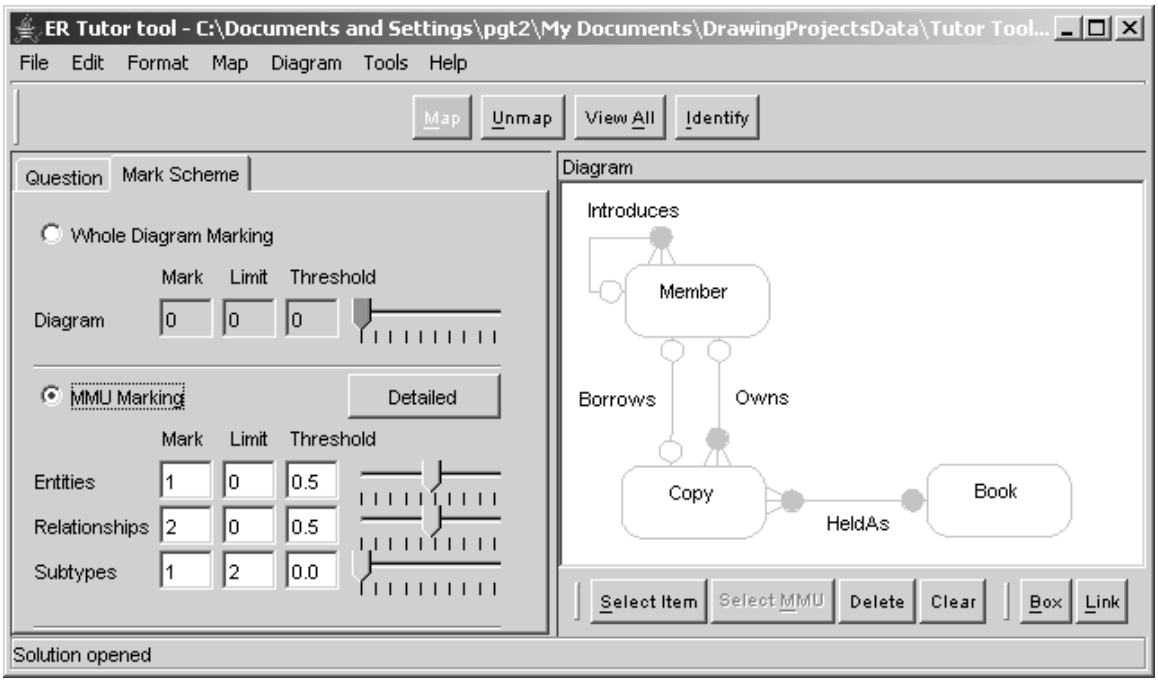

Figure 8 Specifying a mark scheme

The authoring tool has recently been extended to provide a mechanism for specifying mark schemes (see Figure 8).

In Figure 8, an example of 'MMU marking' is shown in which the user can specify a mark for each correct occurrence of each type of MMU. The limit parameter sets a maximum mark for all occurrences of an MMU type (to cope with marking schemes that state, for example, 'award 1 mark for each correct instance of a subtype up to a maximum of 2 marks'). The threshold is a value in the range [0..1] which specifies how well an MMU in the student answer must match an MMU in the specimen solution to be considered worthy of receiving credit (an entity in the student answer will only receive a proportion of the single mark on offer if it is found to match with a solution entity type with a similarity greater than or equal to 0.5). The proportion of the marks on offer actually awarded to an MMU is determined by the similarity measure and, if requested, rounded to the nearest half-mark.

This scheme treats all instances of an MMU type equally. In mark schemes where specific MMUs are to be weighted differently, the tool allows marks to be assigned to MMUs individually—the 'Detailed' button reveals a template for doing this.

Assessment tools

The automatic marker is available as a stand-alone tool primarily aimed at batch processing. In this form, it is capable of providing the teacher with useful feedback on the performance of students. For example, it can show the frequency with which MMUs were found to be missing from student answers. Table 4 shows the frequency of missing relationships in the development set from our large corpus.

It is clear from this data that a large proportion of students had difficulty recognizing the relationships named 'Has' and 'Is' which might indicate some misunderstanding that needs to be followed up in the teaching.

Relationship	Count	%
Receives(Client, Presentation)	26	13.5
Gives(Employee, Presentation)	18	9.3
Prepares(Employee, Unit)	5	2.6
BelongsTo(Unit, Course)	8	4.1
Has(Course, Prerequisite)	140	72.5
Is(Course, Prerequisite)	158	81.9
Presents(Presentation, Course)	77	39.9

Table 4 Missing relationships

During the human marking of the corpus, a slight variation of the specimen solution was discovered. During marking, multiple alternative solutions (not all of which need to be entirely accurate, but which deserve some credit) are often discovered. Depending at what stage the marking has reached and the size of the cohort, such discoveries can be a significant overhead in the marking process. With an automatic marker it is a straightforward and speedy matter to draw the alternative solution and associate a mark scheme with it (using the authoring tool, for example) and set the marker to compare each answer against all solutions and choose the appropriate mark. Our automatic marker assumes that, in general, there will be multiple solutions to a question.

At its current stage of development, one might feel that the technology is not sufficiently reliable to be used alone in a summative environment. We envisage, however, that it could be used as a 'second marker' and its results compared to those of a human marker. In cases where there is a significant discrepancy between the human and the automatic marker, a second human opinion can be requested and hence reduce the overhead in 'double marking' by humans. Thus, the automatic marker can be viewed as a marking assistant.

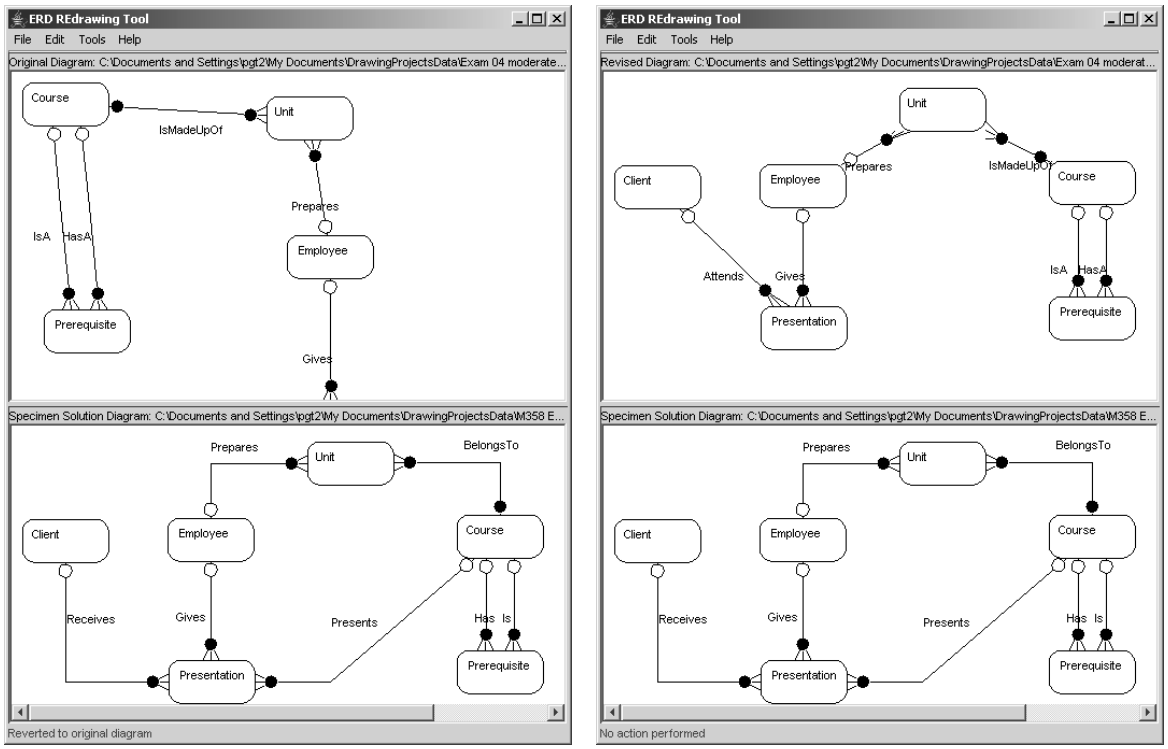

Figure 9 The marker's redrawing assistant

Pursuing the notion that the technology could be used to assist a human marker, we considered those cases where there was a discrepancy between the human and automated marking. In many of these cases it was difficult to decipher the student diagram because its structure was quite different to that of the specimen solution. We felt that the layout of the student answer was making it difficult for the human marker to recognize where marks should be awarded. There is evidence that even experts in the field can misinterpret diagrams (Hungerford et al., 2004). Therefore, we have begun to develop a 'marker's assistant' that redraws a student's answer diagram in a form that more closely resembles the specimen solution and hence makes the diagram easier to assess. Figure 9 shows two screen shots of the interface to the prototype assistant.

The redrawing tool, Figure 9, shows the student's answer in the top pane and the specimen solution in the bottom pane. In the left hand example, the student's answer is shown in its original form and in the right hand example the answer has been automatically redrawn to more closely resemble the specimen solution. It is easier to see the correspondences in the right hand example. The redrawing tool is an extension of the feedback mechanism built into the revision tool discussed earlier.

Conclusion and future work

The experiments we have performed to-date on the automatic marking tool have been encouraging. We have a framework for capturing, processing and interpreting graph-based diagrams that works in a practical learning situation. The interpretation phase applied to the marking of ERDs and compared with human markers has been effective, but we would like to improve some aspects of its performance by increasing the use of NLP algorithms (Manning and Schutze, 2002).

There are a small number of example diagrams in our corpora that are not dealt with sufficiently well by the automatic marking algorithm. In some cases, the deficiency is due to the lack of a more global view of the diagrams. In effect, we focus on MMUs not the larger MUs that might be present in the diagrams. Since have incorporated very little of the aggregation stage of the framework into the marking process it is likely that we will overlook aggregations that may plausibly be equivalent to MUs in the specimen solution. Incorporating knowledge about aggregate equivalences and the way in which one instance of an MMU could contribute useful information when attempting to match other instances of MMU should improve the performance. A start has been made on this aspect and is reported in (Thomas et al., 2006).

We have also begun to investigate the use of the technology in other domains. The revision tool has been modified in a minor way to allow it to be configured with different diagramming notations while retaining its fundamental graph-based properties. Figure 10 shows its use for revising biological flows. In this domain, the weights must be set to reflect the relative importance of the flows to the biological entities.

Acknowledgement

Part of this work was undertaken while one of the authors held a HEFCE-funded Teaching Fellowship of the Centre for Open Learning in Mathematics, Science, Computing and Technology at the Open University.

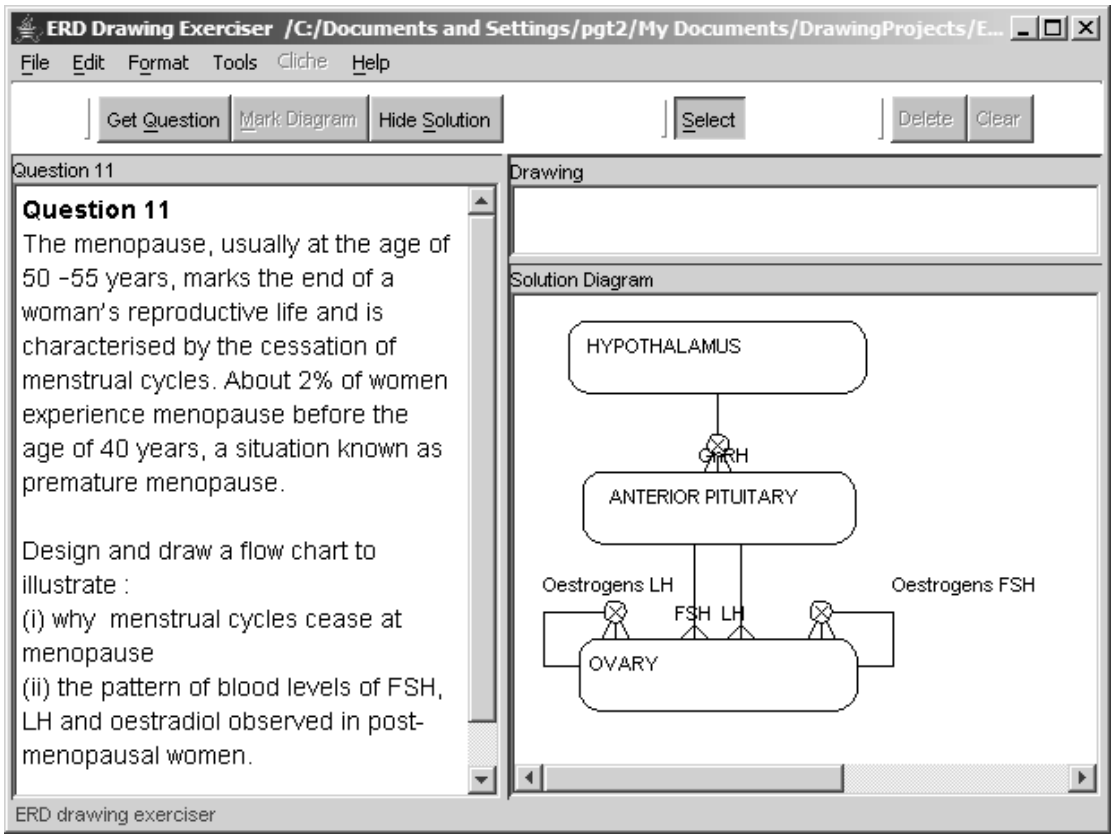

Figure 10 The use of the revision tool in the biological flow domain

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PAPER 1104

Podcasting at RMIT University: evaluating a faculty-based trial

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Abstract

This report describes a 2006 trial provision of lecture podcasts to students in seven business courses at RMIT University, Melbourne. Students were provided with three options for listening to the audio: directly from within the 'Blackboard' site, from a file downloaded to their computer or digital media player, or via an RSS feed.

A survey administered in the final week of semester elicited a 25% response rate, with approximately half of respondents having accessed the podcasts. Reasons given for listening to the podcasts included revision, making up for missed classes, overcoming language difficulties and clarifying concepts.

Introduction

Numerous radio stations, print journals and websites make audio content available as downloadable podcasts, and educators have also been exploring this convenient method of catering to students' needs.

During 2005 and 2006, RMIT University has introduced various initiatives to explore the potential applications of podcasts. These include:

- the provision of audio lecture content in both vocational education and higher education courses
- individual/group assessment items submitted as podcasts by students
- professional development activities focussing on podcast creation and distribution
- the establishment of a community-of-practice (incorporating academic, audio-visual and educational technology staff).

This article discusses the trial and evaluation of podcasting within a selection of business courses at RMIT.

Background

Development of podcasting

The term 'podcasting' emerged in 2004 to describe a specific method of recording and distributing digital audio content via the internet (Crofts et al, 2005). Such a practice was

nothing particularly new or groundbreaking at that time—digital audio recording was a well-established technology, and online file distribution was widespread.

However, several technological developments occurred between 2000–2004, which expanded interest in (and opportunities for) podcasting amongst a broad range of individuals. These include:

- increased internet access/download speeds—particularly **broadband** connections
- the development of particular audio file formats (**MP3**, for example), providing higher compression and smaller files, without a subsequent degradation in quality
- the rising popularity of **blogs** (web-logs), providing opportunities for individuals without specialist web-design skills to publish files and content on the internet (Baker, 2005)
- the development of **RSS** ('really simple syndication'—Hammond et al 2004, Harrsch 2003), an XML-based file format used to generate 'feeds' from web-pages, providing opportunities for subscriptions and automatic notification of content availability
- the rising popularity of personal **digital media players** (particularly the Apple iPod—hence the amalgam '*pod*-casting'), which provide both the portability of 'walkmans' and the convenience/durability of digital media
- the rapid development of larger **storage capacities** (hard drives, archive media and portable devices), allowing for individuals to store and work with larger file sizes.

These developments and their potential applications quickly captured the attention of technology enthusiasts, media producers and the general public alike—to such a degree that within twelve months, 'podcasting' was declared the New Oxford American Dictionary's 2005 Word of the Year (Oxford University Press, 2005).

Podcasting and student learning preferences

As previously discussed, podcasting is one of several technological applications resulting from the recent progression in portable digital devices. Western societies in general—and the 'Generation Y' cohort (defined by Neuborne and Kerwin (1999) as those born between 1979 and 1994) in particular—are rapidly integrating such technologies into various aspects of their lives—work, entertainment, socialisation and education.

This has led to the creation of an 'always on' culture of connectivity amongst the users of mobile phones, personal digital assistants, laptop/palmtop/handheld computers, etc, with such individuals variously described as 'electronic nomads' (Russell and Holmes, 1996) and 'digital natives' (Prensky, 2001). Those members of society for whom the devices involved—and the networks to which they provide access—are *not* universal or ubiquitous, must assume the guise of 'digital immigrants' (Prensky, 2001). The implication of such terminology is that we are now, very much, living within a **digital society**.

Educational adherents of this perceived digital society believe that it signifies the evolution of mobile learning (m-learning)—in much the same way that the widespread adoption of the World Wide Web in the 1990s gave rise to the original development of electronic learning (e-learning).

Within this conceptualisation, portable digital devices are seen as providing a conduit which could be exploited for the provision of both established forms of educational media (lecture notes, presentation slides, websites, discussion forums, etc) in addition to providing wireless, on-the-move access to those new forms of courseware made possible with emerging technological developments (access speeds, file formats etc—as discussed previously). Lectures delivered as podcasts are the prime example of such material.

However, an important distinction must be made at this juncture: while access to a home computer and the internet has consistently increased, the adoption of 'mobile' technologies

(with the exception of mobile phones) remains significantly lower across the broader population (Lum 2006, Kennedy et al 2006).

It is therefore unclear whether 'digital nativeness' within an educational context reflects the adoption of 'old' technologies (home computer, dial-up internet access), or 'new' technologies (mobile devices, broadband/wireless internet access). For example, Lee et al (2006) suggest that many students engaged in educational podcasting prefer to access/listen to such material on their computers rather than their MP3 players.

To truly predict the potential impact on educational technology of the 'new', emerging mobile trends, further examination of the degree to which students are in fact prepared to use such *specific* nativeness is required.

An additional question is whether those students who have indeed adopted new technologies into their lives for recreational purposes are prepared to utilise the devices within their education.

Campbell (2005) believes that students will be comfortable blending the purposes for which they use their mobile technology:

> *[The student] doesn't notice that the classroom material and the leisure-time entertainment are coming through the same medium and desktop utility; for her, it's natural that school stuff would mingle with other aspects of her daily life. (p. 33)*

Kennedy et al (2006) explored this issue further in a recent survey of almost 2000 first-year, Generation Y students at the University of Melbourne. Results regarding the use of MP3 files and podcasts were quite encouraging: while 58.4% of respondents reported downloading such files outside of their educational context, 60.6% expressed a desire to do so to assist with their studies.

Podcasting activities within RMIT University's Business faculty

Academic staff in RMIT University's Business faculty have been recording their lectures and making the audio files available to students for several years—using audio cassettes or CDs originally, and updating the service to use audio-streaming and podcasting as such technologies have become available. This has largely been done and evaluated on an individual basis.

In 2005, a lecturer in Company Law approached staff from the faculty's Academic Development Group (ADG) to discuss the options available for providing her students with recordings of the class lectures. The technology associated with creating and distributing podcasts was discussed, and the lecturer agreed to trial the procedure. This was largely conducted informally; however anecdotal evidence suggested that a larger trial may prove beneficial.

Therefore in semester 1 2006, the ADG proposed an evaluative trial of podcasting in several undergraduate courses. The principle aim was to investigate the benefits and issues for the student, the lecturer and the technical support team, with an emphasis on improvements to teaching and learning. A secondary aim was to explore how the participating students would use their access to various technology (eg: computers, digital media players, etc) to utilise the podcasts within their learning.

Method

A call for volunteers was made via the faculty's weekly email newsletter. Six lecturers agreed to participate, and lectures were recorded from a total of seven courses. For one of these (Company Law—the course initiating the original trial in 2005) lectures and tutorials were

both recorded, while for another (Commercial Law) separate recordings were made of both day and evening classes.

Lecturers were provided with portable digital recorders, and technical staff demonstrated how to operate these (attaching microphone, recording, connecting to computer via USB, etc.). Following each recording, lecturers would upload the audio file to a University server and notify technical staff via email. Amongst the majority of trial participants, this generally occurred within 24 hours of the class—although one lecturer purposefully waited until a week later, in order to limit student access to the file (thereby making the podcast a 'review-only' resource).

For each of approximately 12 files per week, the following procedure was followed:

- Raw WAV file uploaded from digital recorder to file server by course lecturer
- Minor editing and file conversion performed by technical staff
- Final MP3 file uploaded to University web server, with appropriate header information, by technical staff
- Links created in course Blackboard site (see figure 1) within the University's learning management system by technical staff, providing students with three alternative access methods:
  - streaming directly from the Blackboard site using the in-built audio player (requires high bandwidth Internet connection).
  - downloading the MP3 file for off-line playback on either a local computer or a digital media player
  - subscribing to the provided RSS feed, and acquiring a podcast via an 'aggregation' application (iTunes, Bloglines, Juice, etc—see figure 2).

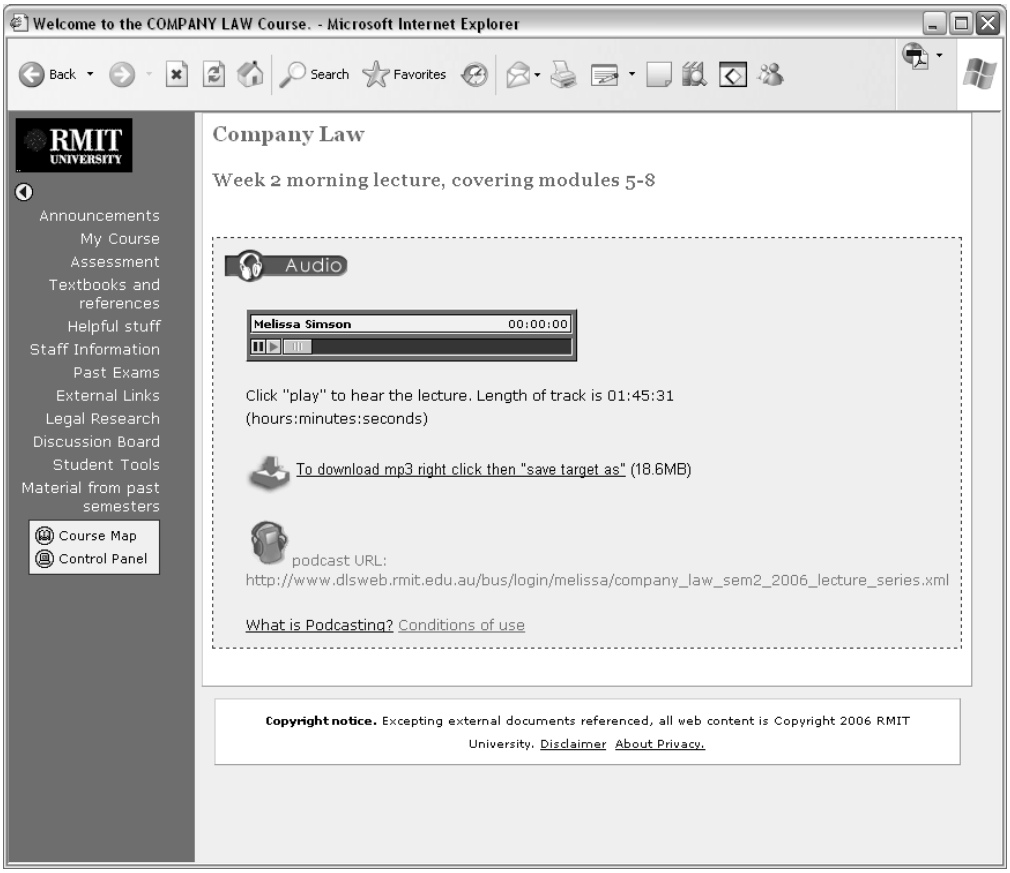

Figure 1 Blackboard interface showing three access methods (in-built audio player shown at top)

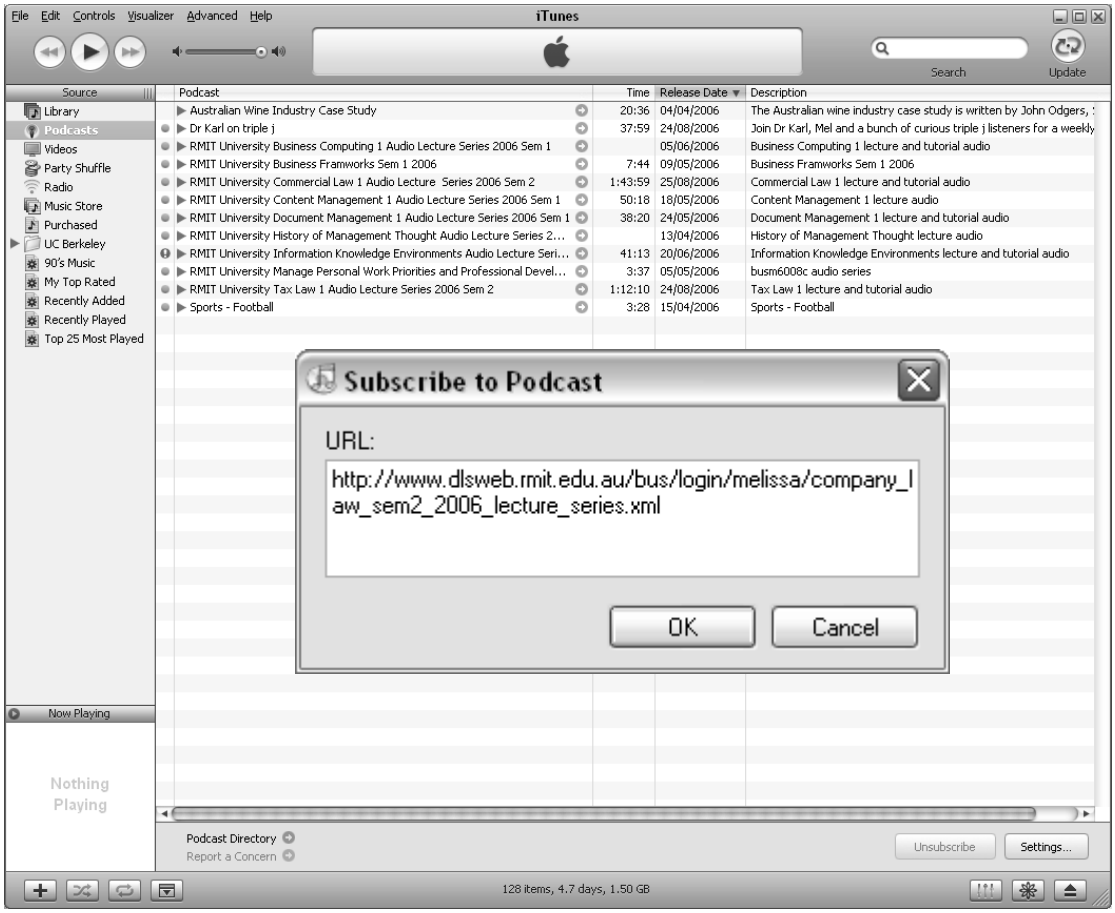

Figure 2 Using iTunes software to subscribe to the RSS feed for a podcast

Students were able to access the files from the course Blackboard site within 48 hours of the lecturer uploading the audio recording to the file server. On average it took approximately 45 minutes of technical support time to process each file.

Results of the evaluation

Students

A survey form was handed out in the last week of semester. Table 1 below shows an overall response rate of just over 25%, with individual rates varying from 20% in the large classes to 75% in the very small class.

Of the respondents to the survey, 51% were female and 49% male. Quite a large proportion (38%) did not have English as a first language, compared to 62% native English speakers.

Course	Total students	Surveys completed
Information and knowledge environments	75	30
Document management	160	37
Business computing	800	155
Content management	20	15
Commercial law	700	206
Company law	250	71
Taxation 1	140	43
Total	**2145**	**566**

Table 1 Survey responses within each course

Approximately half of the respondents listened to the podcasts. Of these, almost 60% downloaded the file to their own computer to listen. Only 4% subscribed to the RSS feed, although 14% claimed to use a portable audio player—indicating than many students used methods other than subscribing to the RSS feed to transfer audio files from their computer to the iPod (see Tables 2, 3 and 4).

Value	Frequency	Percentage
Yes	283	51.3%
No	269	48.7%
Total responses	**552**	

Table 2 Responses to Question: Do you listen to audio files of your lectures?

Value	Frequency	Percentage
Computer on campus	52	14.9%
Computer off campus	248	70.9%
Digital media player	50	14.3%
Total responses	**350**	

Table 3 Responses to Question: HOW do you usually listen to the audio files?

Value	Frequency	Percentage
Listen using the in-built audio player in the course website	132	37.3%
Download the MP3 file	208	58.8%
Subscribe to the RSS feed using iTunes or similar	14	4.0%
Total responses	**354**	

Table 4 Responses to Question: Which FORMAT do you usually use to access the audio files?

The audio files were more popular

- for part time students (68% used it compared with 45% of full time students: see Table 5)
- for those for whom English is not a first language (65% used, compared with 42% of English speakers: see Table 6)
- for students in Law subjects (61% used, compared with 39% of BIT students: see Table 7)

Listen to audio?		Full time	Part time
Yes	count	171	39
	% within study status	44.8%	68.4%
No	count	211	18
	% within study status	55.2%	31.6%

Table 5 Responses to Question: Do you listen to audio files of your lectures? By Study Status

		English first language	
Listen to audio?		**Yes**	**No**
Yes	count	134	131
	% within English as first language	41.6%	65.2%
No	count	188	70
	% within English as first language	58.4%	34.8%

Table 6 Responses to Question: Do you listen to audio files of your lectures? By English as first language

		Discipline	
Listen to audio?		**IT**	**Law**
Yes	count	91	192
	% within discipline	38.6%	60.8%
No	count	145	124
	% within discipline	61.4%	39.2%
Total responses		**125**	**234**

Table 7 Responses to Question: Do you listen to audio files of your lectures? By Discipline

There was higher proportion of females than males using podcasts (56% of females compared with 46% of males: see Table 8).

		Gender	
Listen to audio?		**Male**	**Female**
Yes	count	117	153
	% within discipline	45.7%	56.2%
No	count	139	119
	% within discipline	54.3%	43.8%
Total responses		**256**	**272**

Table 8 Responses to Question: Do you listen to audio files of your lectures? By Gender

There was little difference in usage between the younger and older age groups (see Table 9), with a slightly higher proportion of older students using the podcasts.

		Age Group	
Listen to audio?		**17–25**	**Over 25**
Yes	count	218	58
	% within discipline	49.5%	59.2%
No	count	222	40
	% within discipline	50.5%	40.1%
Total responses		**440**	**98**

Table 9 Responses to Question: Do you listen to audio files of your lectures? By Age group

For those who listened, the average number of recordings accessed was 5.3 over the course of the semester. Almost 80% read their lecture notes while listening. The most common reason for listening was because of a missed lecture (43%), while 34% used the audio recordings for revision prior to an exam (see Table 10).

Value	Frequency	Percentage
Review a lecture shortly after attending the class	74	23.2%
Listen to a lecture that I have missed	137	42.9%
Revise my course prior to a test or exam	108	33.9%
Total responses	**319**	

Table 10 Responses to Question: What is your main PURPOSE for accessing the audio files?

Just over half of the podcast users listened to the entire lecture, and a similar proportion used the fast-forward and rewind facilities. By far the most common reason for rewinding was to review a concept that they did not understand, with the second most common reason being language difficulties (see Table 11).

Value	Frequency	Percentage
You walked out of the lecture at this point?	17	9.0%
You found the acoustics of the room difficult which made it hard to hear?	30	16.0%
You did not understand the language?	41	21.8%
You did not understand the concept of the lecture content at this point in the lecture?	100	53.2%
Total responses	**188**	

Table 11 Responses to Question: Is the reason WHY you used fast forward or rewind because: ?

Of those respondents who used the podcasts, 92% rated the audio quality ‘Good’, ‘Very good’ or ‘Excellent’, 80% found the audio to be ‘Useful’, ‘Very useful’ or ‘Extremely useful’ to their learning, and 93% rated the overall quality of the service as ‘Good’ or better (see Tables 12, 13 and 14).

Value	Frequency	Percentage
Very poor	9	2.6%
Poor	34	9.8%
Good	202	58.0%
Very good	80	23.0%
Excellent	23	6.6%
Total responses	**348**	

Table 12 Responses to Question: Please rate the sound quality of the audio files

Value	Frequency	Percentage
Not useful	24	6.4%
Slightly useful	54	14.3%
Useful	122	32.4%
Very useful	110	29.2%
Extremely useful	67	17.8%
Total responses	**377**	

Table 13 Responses to Question: Could you please tell us if you thought the audio was useful to your learning experience?

Value	Frequency	Percentage
Very poor	5	1.4%
Poor	22	6.1%
Good	176	49.0%
Very good	97	27.0%
Excellent	59	16.4%
Total responses	**359**	

Table 14 Responses to Question: Overall, how would you rate the service?

Law students were more likely to give high praise than information technology and information management students. 48% of the students in law subjects rated the overall service as 'Very good' or 'Excellent', compared with 26% of IT students providing such responses (see Table 15)

		Discipline	
Overall rating of service		**Information Technology**	**Law**
very poor	count	1	4
	% within discipline	0.8%	1.7%
poor	count	9	13
	% within discipline	7.2%	5.6%
good	count	71	105
	% within discipline	56.8%	44.9%
very good	count	26	71
	% within discipline	20.8%	30.3%
excellent	count	18	41
	% within discipline	14.4%	17.5%
Total responses		**125**	**234**

Table 15 Responses to Question: Overall rating of service By Discipline

Approximately one quarter of respondents added meaningful written comments at the end of the survey form. The overwhelming majority of these were positive, although 10% said they did not need to access the audio files because they attended all classes and obtained sufficient information from them. Over one third of the positive responses (28 respondents) wanted audio files available for all of their courses and/or tutorials. The most common use mentioned was for revision (20), followed by missed classes (13) and language difficulties (5).

Suggestions for improvement included:

- improving clarity
- indexing the lecture into chapters
- announcing slide numbers or change of slide
- making it easier to hear student questions.

Five respondents wanted the audio posted sooner after lectures, while only one commented on difficulties downloading large files over a dial up connection.

Among the positive comments:

> *"They were excellent because you can pause; look up things you might not understand in the text, write a summary then continue on. Also, I can fit them in around my life."*

"The service is amazing. Wish all my subjects provided this. Great for covering material in missed lectures, revision and exam study. I usually listen while cooking dinner then read relevant chapters after tea!"

"Audio is very vital as it is usually difficult to follow what the lecturer is saying during the lecture as it is too fast. Audio enables me to press pause, write down the notes fully and then get back to listening to the audio."

Balanced by a rare negative one:

"Do not like the monotonous tone or organisation of the lecturer. Most likely the biggest shamble and waste of time that turns the [online learning environment] into a terrible and depressing place!"

Lecturers

Five of the lecturers responded to set questions on their experiences with the trial. Three of them had been recording lectures for the past two years, while for another lecturer this was the second semester of using recordings. The one respondent who was new to the process spoke of being initially daunted by the technology, but then finding it simple to use once it was explained by technical staff.

Selected responses to each question are presented below.

Why did you engage with the project in the first place?

"[I have] a large number of international students that benefit from having the recordings to revise parts of the lecture where language is an inhibitor to their learning."

"[My] lecturing style is discursive, and I find that students benefit from having the audio to be able to go back and revise."

"[My] daughter who studied at the University of Melbourne relied on lecture recordings a lot, because of work commitments.

"I felt that the use of lecture recordings would be a modern technology to assist in my aim to 'keep up with the times'."

"[I had] perceived a general student need where there were absences due to either illness or part-time work commitments and those who wanted to revise the material for assessment purposes."

"[My interest] came from knowing that this service is available to students at other Universities. [I had also] observed some students taping the lecture themselves."

"Students today are more mobile and receive their information from various sources … we need to deliver information in a way that suits today's world."

Did you perceive any benefits?

"A benefit for the student is to be able to go back to the audio at a later time to listen to concepts they did not understand. Students also use the audio to revise for assessment. The portable format allows students to listen whilst not stuck in one place."

"There has been comment from only one student, who missed a lecture, that the lecture recordings were valuable."

"The recording was a language aid and provides a record of what was said when putting words together."

What changes if any have the recordings made to your *teaching* of the students—did you modify your delivery in any way?

"There was no change in teaching method. Some student questions came through on the audio, and students made reference to the fact that this was meaningful to them."

"No changes other than the audio 'tag' at the beginning [of each lecture] to identify the recording."

"[I now use] a more formal approach that is clear and in a directed sequence that refers to the slide numbers in the presentation."

"I was aware of the audience and made audio references to the current PowerPoint slide. Also, when a student was speaking, I stood next to them to capture their audio on the radio microphone."

"I was aware that student questions would not be recorded so I sometimes worked the question into the answer."

What changes if any have the recordings made to the *learning* of the students?

"Students do refer to the audio … if the audio was late going up, I would receive a few emails asking for it. There is a sense that students use the audio for both weekly and semester revision."

"None that I am aware of."

"[I have] noticed there are less students requesting personal contact or using email to ask questions, which indicates a possible self direction from students in seeking answers to their questions from the audio."

"The audio has been used as an adjunct to the lectures."

Would you do anything different next time?

"I would label the start of the lecture with an audio tag, and speak slower."

"No changes except any that may be relevant as a result of the student survey."

"Generally, there may be more interaction in lectures. Also, it would be good to have the students' questions and comments come through on the audio."

"[I] would like to think that there is a succession plan in place so when the time comes, the next lecturer to take over uses the recording."

How would you feel if your material was available on a public website (no login required)?

"This is done elsewhere and I think the answer lies in what the University policy would be—but I am [personally] okay with it."

"[I am] not keen on public availability, and would prefer the material to be available to students only."

What advice would you offer to colleagues considering lecture recordings in their teaching?

"I would encourage other staff to participate."

"Once again, [this is] dependent on the student evaluation."

"[I have] spoken to other staff and received some opposition from them based on thoughts … that the recording of lectures would make them redundant, students would not attend lectures, there would be redundancies and finally, that they did not want to be held to what they said."

Technical staff

Two technical staff members from the ADG shared the task of editing, uploading and linking the audio files. The technicians were more open than either lecturers or students in pointing out issues with the audio recordings.

Minor problems included:

- the logistics of providing a replacement when the digital recorder was lost
- broken microphone clips
- low battery levels
- recording non-relevant conversation
- noise interference from extraneous items close to the recorder.

The production process was slightly different for each lecturer, necessitating efficient process documentation and particular care being taken when processing multiple files during peak times.

Discussion

Of the three methods which students could use to access the recordings, manually downloading the MP3 file was by far the most popular, while the use of the RSS feed—considered by some as an essential element of 'podcasting'—was minimal.

There is an assumption amongst educational technologists and Web 2.0 adherents (Duffy et al 2006, Kamel Boulos et al 2006, Lankshear and Knobel 2005) that RSS has been adopted by a wide proportion of the general population—particularly the 'Generation Y' cohort. The results of this study suggest that students are either less familiar with RSS feeds and subscriptions than has been assumed, or perhaps they have no interest in incorporating such technology into their learning.

It would be of interest to explore whether the inclusion of student briefing sessions would impact the use of this feature.

Interestingly, less than 15% of student respondents listened to the recordings using a digital media player—with the remainder accessing the files using on-campus and off-campus computers. This contrasts quite strongly with recent findings at the University of Melbourne (Kennedy et al, 2006), where 60.6% of surveyed students expressed an interest in using such devices to access study-related podcasts.

This also draws into question the hypothetical scenario of the near-future 'digital native' students who seamlessly blends their recreational and educational podcasting; subscribing to both via RSS feeds, and downloading them together to their digital media players (Campbell, 2005). However, this may not be the case—despite the large proportion of students anecdotally reported to possess such devices, a minority seemed to express an interest to use them for lecture podcasts.

In 2004 Duke University provided 1600 students with iPods, preloaded with orientation material (Lum, 2006). Duke has since expanded their use of these devices across 47 courses which apply the technology in a variety of ways. It would be of interest to determine whether such an initiative at RMIT University would affect the percentage of students listening to recordings on portable devices; could a 'study iPod' be imbued with a similar specificity of purpose as a 'work laptop'?

Conclusion

The trial was deemed a considerable success. Many hundreds of students listened to the podcasts on a regular basis, and gave positive feedback on the experience.

The service was particularly popular with:

- part-time students
- students with English as a second language
- students in law subjects

Specific benefits were seen as:

- catching up on missed lectures
- revision prior to an exam
- repetition of difficult concepts

Some student criticisms can be addressed by ensuring lecturers are aware of the need to provide audio cues to indicate the topic, section headings and relevant slide numbers. Lecturers should also be careful to turn off the recording device during private conversations with individual students or other staff.

This trial involved six lecturers from across two academic disciplines. Approximately 20 recordings were processed each week, involving two technicians in a total of 15 hours work per week. While the technicians were able to cope with the logistics and the workload from this trial, the manual system is not scaleable.

The technical team believed that these issues could be avoided in a larger trial by the introduction of a built-in automatic recording system such as ‘Lectopia’, as used in other universities (Sait et al, 2006). Such systems can capture lecture presentations and video recordings of a lecture, as well as audio recordings. A large majority of students in this study read their lecture notes while listening, indicating they rely on more than just the lecturer’s words for their information.

There was sufficient positive response to this trial to recommend the implementation of a larger scale automatic recording and playback system. However consideration must be given to those class sizes and lecture styles that are best suited to recording. Staff must also be given the opportunity to explore ways of optimising their delivery style to ensure maximum student learning from the recordings.

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PAPER 1124

Assessing the impact and potential of podcasts as pre-lectures

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Abstract

We describe the incorporation of podcasts as pre-lecture preparation to provide advance exposure to conceptually difficult topics in elementary undergraduate Physics. We assess the effectiveness of such instruction via in-lecture questions, recording student responses using personal response system handsets. The exposure to the podcast prior to the questions has a small, yet consistent, positive influence on the proportion of students answering a series of concept questions correctly. The outlook for using such strategies in undergraduate Physics teaching is discussed.

Introduction

A compound of the words iPod and broadcasting (originally coined in 2004), a podcast is an audio recording that is delivered, via the Internet, to users using RSS (really simple syndication). This allows the user to 'sign up' (or subscribe) to the podcast by adding a feed to an aggregator program that will automatically download episodes as and when they are available. The concept was first suggested as early as the year 2000 but the first practical applications of the technology began appearing in 2003, with adoption and uptake growing rapidly. More recently, the idea of podcasting has been widened to include video content or 'vodcasting'. The growth rate is staggering; the total number of managed feeds is over 500,000 (Feedburner, 2007).

It is therefore no surprise that this expansion, fuelled by the widespread availability and low cost of personal hardware, has given fresh impetus to educators to exploit the opportunities this offers. Apple have sold 8.5 million iPods in the last quarter of 2006 alone and students are some of the biggest buyers of consumer electronics like laptops and personal audio players. Whether or not this is genuinely a novel educational development, or merely a re-invention of an old wheel in a new technological guise is a point of debate for some. However the response from the educational community has been swift: as of October 2006 the iTunes Music Store lists over six thousand podcasts in the education category.

A major challenge is to successfully establish mechanisms that integrate these new technologies into the curriculum, in pursuit of enhanced and / or more flexible, "learner-centered" learning. This study aims to specifically investigate the utility of podcasts to support

student learning, particularly in the context of two common misconceptions in introductory Physics. We have used in-class electronic voting systems to allow us to capture quantitative data. The range of potential uses for a podcast within an educational context is broad; a good summary is presented in annotated case study form (Nie, 2007). However, much effort is currently devoted to the production and podcasting of education content in the forms of lectures, allowing students to download them if they miss lectures or review later for revision purposes. Both Stanford and Berkeley universities have Apple-sponsored podcast directories (Apple, 2006). Within the UK, the IMPALA project (Impala, 2006) has collected a valuable repository of online materials (papers, screencasts etc) covering the broader pedagogical possibilities offered by podcasts (Nie, 2006), case studies of use to provide supplementary materials (Edirisingha, 2006), and orientation to future in-class activities (Woodward, 2007) going far beyond the simple act of a digital recording of a lecture.

This paper addresses the use of podcasts as pre-lecture resources, to provide advance exposure to conceptually difficult topics to be covered during class teaching in the following week. Our aim is to explicitly test how, if at all, podcasts can be used to enhance student understanding of these concepts, in a subject context that traditionally relies on visual representation to communicate concepts. We briefly describe some of the theory behind why this might be expected to be valuable, followed by a description of the experiments we performed in order to obtain some quantitative data on the usefulness of prior exposure to material. We then evaluate the results, together with some qualitative feedback from students on the use of podcasts as a means of providing both content and supplementary resources, and end with conclusions that can be drawn for the future.

Theory

Audio has been cited as “vastly neglected and underused as a teaching and learning medium” (Lee, 2005), with a possible reason being that listening to audio is not classed as “learning” and that listening is “not synonymous with comprehension and action” (Walsh 2004, p25). Yet audio has been cited as offering advantages compared to text by being able to influence both cognition and listener motivation (Durbridge, 1984). Studies into the use of television, radio and tapes have been undertaken even as early as the middle of the last century. For example, (Popham 1961, 1962) performed an investigation that split a class into those who attended normal face-to-face lectures, and those who were given recordings of the lectures on tape and attended smaller discussion sessions. The two sections were evenly matched according to scholastic aptitude tests and pre-course achievement tests (even though the split was voluntary) and after the course Popham found no significant difference between them. Popham’s work was extended (Menne, 1969) where students were provided with tape players, allowing them to work through the course at their own pace. They similarly found no significant difference between the groups, but when comparisons between quartiles of different ability were made, there was a clear advantage in using the tapes for the lower quartiles.

From radio broadcasts, through cassettes and later CDs for open and distance learning, the medium of delivery has now moved on to digital audio and portable music players, reflecting changes in lifestyle and society (Clark and Walsh, 2004). Fryer on his education-themed weblog (Fryer, 2006), has stressed the importance of appealing to students’ interests:

> *“Identifying novel and enticing teaching techniques requires educators to acknowledge and exploit student interests, which make learning more appealing and efficacious.”*

Indeed, the social and cultural dimension to a learner’s development has often been strongly emphasized, back to Vygotsky in the 1930s. An issue of debate has been that of whether content or context matters more (Clark, 1983, p445);

> *"…media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition. Basically, the choice of vehicle might influence the cost or extent of distributing instruction, but only the content of the vehicle can influence achievement."*

Clark also recalls Salomon (Saloman, 1981), who modelled students' attitudes to certain media as a probable cause of differences in achievement. Salomon suggested that students may perceive the 'difficulty' of learning from different media and that these perceived difficulties would affect the resulting effort they will invest. For example, he found that many students thought of learning from television as "easy", but those that were taught solely by television performed more poorly than those taught with "difficult" media.

As the novel practices of deploying podcasts in an educational context become more widespread, initial and pilot studies of the impact of these on student engagement or achievement are beginning to be published. These aim to address the educational benefits rather than simply reporting technical aspects. Chan and Lee have described a pilot study that uses podcasts to address student preconceptions and anxieties on an information technology course at an Australian University (Lee, 2005; Chan, 2005). A subsequent study investigates student-generated podcasts (with minimal staff input), prepared to support new students (McLoughlin, 2006). A study in Engineering in Leicester (Edirisingha, 2006) describes the use of "profcasts", material distinct from on-campus teaching or self-learning activities. The same authors also propose a model for integrating these within blended learning environments.

This work seeks to investigate the effect of pre-lecture podcasts to aid student understanding of conceptually difficult topics in university Physics; the two examples we have chosen are the forces acting on objects and rotational motion. Both are well-documented challenges for students studying the subject at university level (Hestenes, 1992).

Method

The context for this investigation is the introductory first-year Physics course at the University of Edinburgh, the pedagogical design details of which have been reported elsewhere (Bates, 2005) together with details of students' behaviour in using the online support materials to aid learning (Hardy, 2005). The course has an extensive online component to complement face-to-face teaching. The course enrolls approximately 250 students. In recent years, we have successfully integrated an Electronic Voting System (EVS) into whole-class lectures (Bates, 2007), which is the mechanism used to collect student responses to various questions during the lectures for later analysis. The handsets are issued to students at the start of the course, and retained for its entire duration. Loaned to students like a library item, we retain a record of which student "owned" which handset.

The main challenge for this investigation was how to provide clear, systematic, and reliable data to support ideas that are, at worst, wholly abstract. We chose to create two podcast episodes, one targeted at each of the areas of difficulty, to be delivered ahead of the material being covered in class, a few weeks apart. The podcasts were designed to engage the students with the material and to prompt them to think about what would be covered in the following lectures, and question their own understanding about the topics based on any previous exposure to them. They contained relevant examples to contextualise the material, and were both approximately 8 minutes long. Scripts are available online (Stevens, 2007).

The class was divided into two groups according to the days of attendance at course workshops. (Students sign up to whichever workshop day they choose, or their timetable permits.) Those electing to do workshops on Monday and Tuesday were allocated as being in Group 1, those on Thursday and Friday in Group 2. In the first experiment, the podcast

was delivered to Group 1 students at the start of their respective workshops. Three days later, the whole class was posed various concept questions at the start of a lecture. These were answered in the usual way using the EVS handsets and data saved for analysis. A few weeks later, the experiment was repeated with Group 2 receiving the podcast in their workshops and the whole class being questioned three days later. In effect, by repeating the experiment in this way, each half of the class acts as a control group for the other half. Issues of equity are addressed, as each student received one (and missed one) podcast.

By broadcasting the podcast, we were making use of a captive audience. In fact, it is suggested by other pilot studies that the majority of students play podcasts as downloads through a PC (Woodward, 2007). In some respects, it may seem that we had somewhat artificially distorted the concept of a podcast, by not offering it for download. If it were offered for optional subscription or download to a selected portion of the class, we could not be sure of uptake. The issue of mobility is not crucial here; we are not looking to open up new learning avenues by exploiting the fact that the material could be used anywhere. Instead, we are aiming to tap into student self-study time, be that on the move or at a PC.

A more important issue was to ensure that, on average, the two groups of students could be considered equivalent in ability. This was evaluated on the basis of student performance in an online diagnostic test undertaken at the start of the course, based on the standard physics concept test, the Force Concept Inventory (Hestenes, 1992). The two groups (N=85 and 88 students respectively) had mean scores of 18.6 and 18.0 (both out of 33), with standard deviations of 6.1 and 7.1 respectively. The two distributions returned a Student T-test value of 0.35, suggesting there is indeed no significant difference in ability between the groups (95% confidence level).

The first podcast episode, delivered to students on Monday 9th and Tuesday 10th of October 2006, was designed around the well-documented problems encountered by a high proportion of entrant undergraduate Physics students in correctly applying Newton's Laws to everyday situations. A classic example question (used in the evaluation of the effect of the podcast, see the section on Results, below) is shown in Figure 1. In previous years of teaching the course, the vast majority (often tending towards 100%) of the students have chosen answer 2, whereas answer 3 is correct. Answer 2 exhibits a fundamental miscomprehension of Newton's 3rd Law.

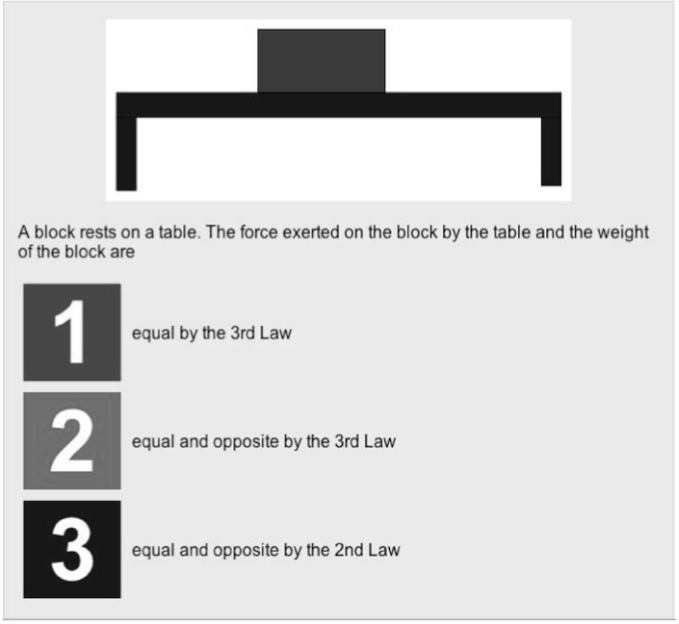

Figure 1 Question used for podcast 1

The podcast was therefore designed to address this problem by reinforcing important concepts, providing examples, and encouraging the students to take time before the lecture to do some background reading or even just think about some problems. It was decided to explicitly avoid actually stating an example similar to the one in Figure 1 ("block on table"). A script was created, using bullet points to identify the main topics. In addition to these, (Creative Commons) music and sound effects were used to try and engage the listeners.

The second podcast episode was delivered four weeks later, allowing for a period of reflection on what could be improved upon for the next presentation. Several important lessons were learned, following preliminary analysis of the responses to the question in Figure 1 (see later). Modifications from both reflection on our own aims and practices and from resources online included the following:

- In the first podcast, the content was designed loosely around the question, with the expectation being on the students to be able to identify the question a few days later as one that illustrated the misconceptions the podcast was designed to highlight. For a question that so few students get correct year after year, this was overly optimistic.
- For the second podcast, content and questions were developed together. An initial question was used as a starting point, one that had seen much use previously and had typically produced very poor performance. Three others were also designed, each to address a particular misconception about angular momentum. The content of the podcast would then be designed specifically aimed at resolving these misconceptions. More than one such question would additionally enable us to gather a greater amount of data, rather than relying on just one question.
- Informal feedback on the usefulness (or otherwise) of the first podcast was sought from students during workshops. They commented that the music made them 'switch off' in between the sections and actually made it less easy to remember. A long period of uninterrupted speech would potentially be even worse than music intersecting it, so it was decided to use two separate voices to give a conversational tone to the podcast.
- We related the material directly to that used in a formal teaching environment (the lectures), by using two "personalities" who crop up frequently in the course. "Alison and Billy" (A and B) are used during lectures to concretize abstract algebraic examples.

The questions were designed first, and the podcast content followed. A decision was made to use a simple, every-day example (observing a car being driven) that included all these different aspects and to state some of the actual misconceptions in the script. The questions are illustrated in Figure 2. The first is designed to lead the students in gently, with a very easy and often-stated example. Number 2 is the original question from previous course content, similar to that shown in Figure 1, in the sense that a similarly small (often negligible) number of students choose the correct answer (2). The classic misconception in this case is illustrated by choosing answer 1. Questions 3 and 4 are designed to test the students understanding of how different choices of origin and changing velocity influence the angular momentum of the object. The correct answer in both cases is 3. These two questions are similar in scope, and go beyond the concepts tested in the previous question.

The podcast was then delivered to the Group 2 (on Thursday 9th and Friday 10th November) and the above questions posed in the lecture on the following Monday. The total number of respondents for these questions varied between 99 and 105.

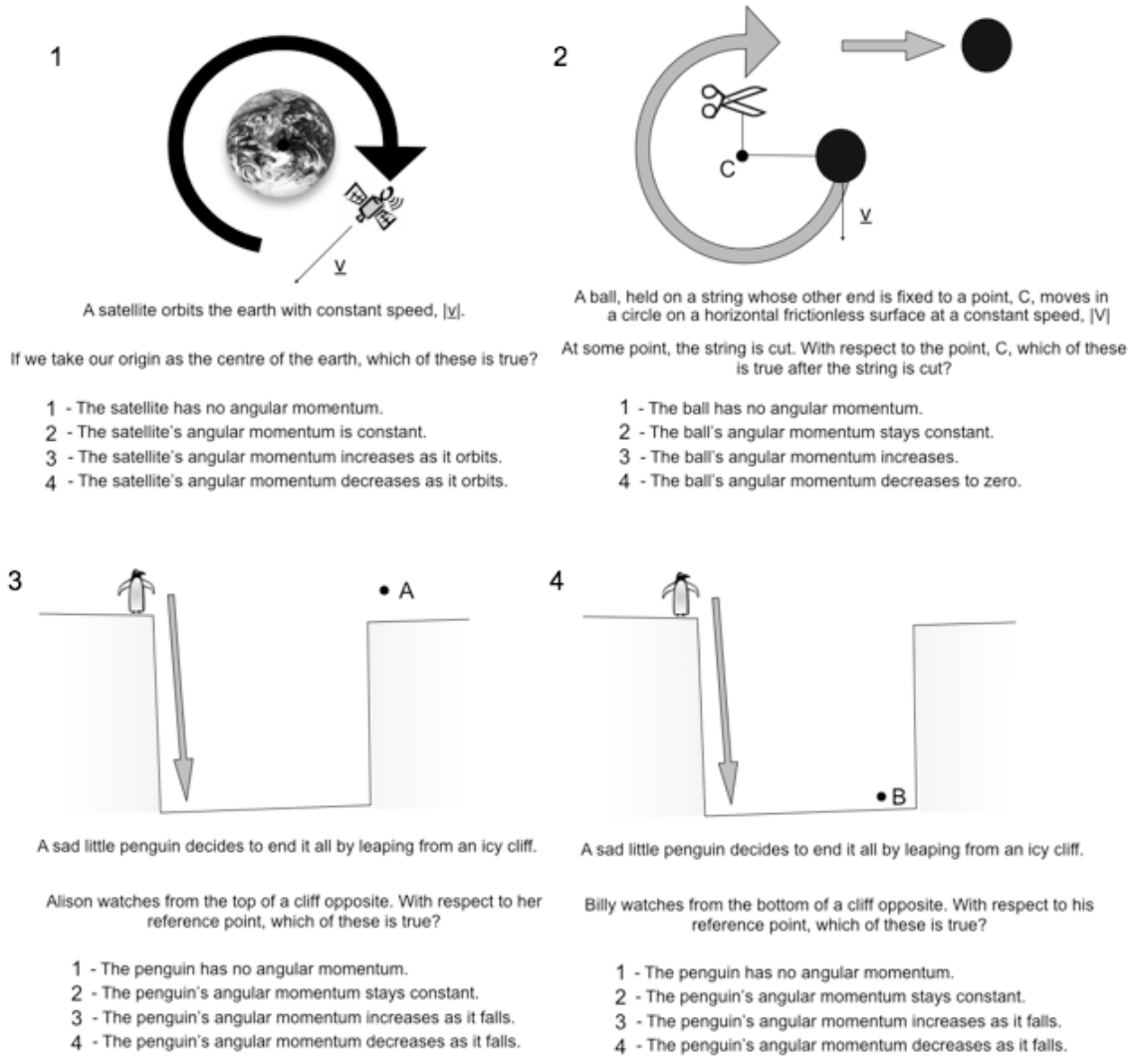

Figure 2 Questions used to evaluate the second podcast

Data analysis, Results and Discussion

A record of handset ownership enabled us to correlate answers with group membership. In analyzing results, we made a number of pragmatic assumptions:

- Students attended workshop classes on the days they were allocated to attend them.
- Students brought and used their own handset in lectures
- Students answering outside the possible choices (e.g. number 4 or above for the question shown in Figure 1) were discounted.

Despite starting with a large class cohort (over 200 students), the effective subset answering the in-class questions was reduced to around half. 'Lost students' came from many sources: some did not obtain a handset for the course, some were not registered for workshops, did not attend the relevant lectures or didn't answer the questions in the lecture.

Figure 3 shows the resulting profile of answers for the whole class for the question illustrated in Figure 1. In this, and all subsequent results, the figure at the base of each bar indicates the percentage of students choosing that answer and the box indicates the correct answer.

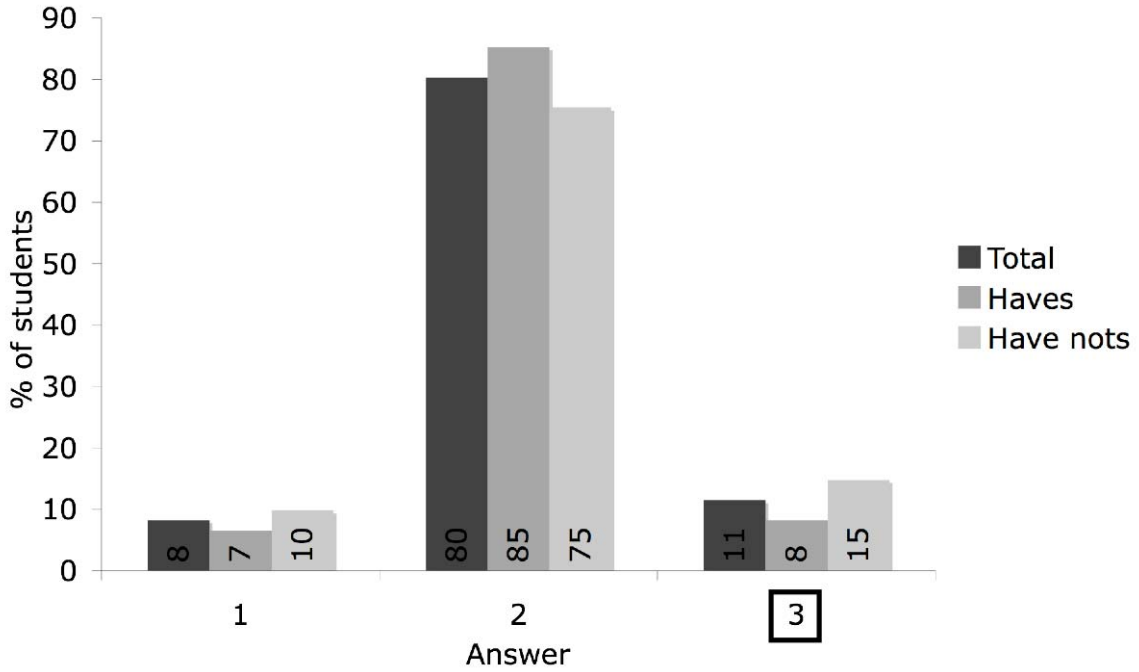

Figure 3 Response distribution for "block on table" question (N=122)

The results are disappointing: not only did the vast majority of students still slip on the inevitable banana skin, fewer of the group of students exposed to the podcast chose the correct answer. However, with so few students getting a single question correct or not, it is not possible to draw anything meaningful from this.

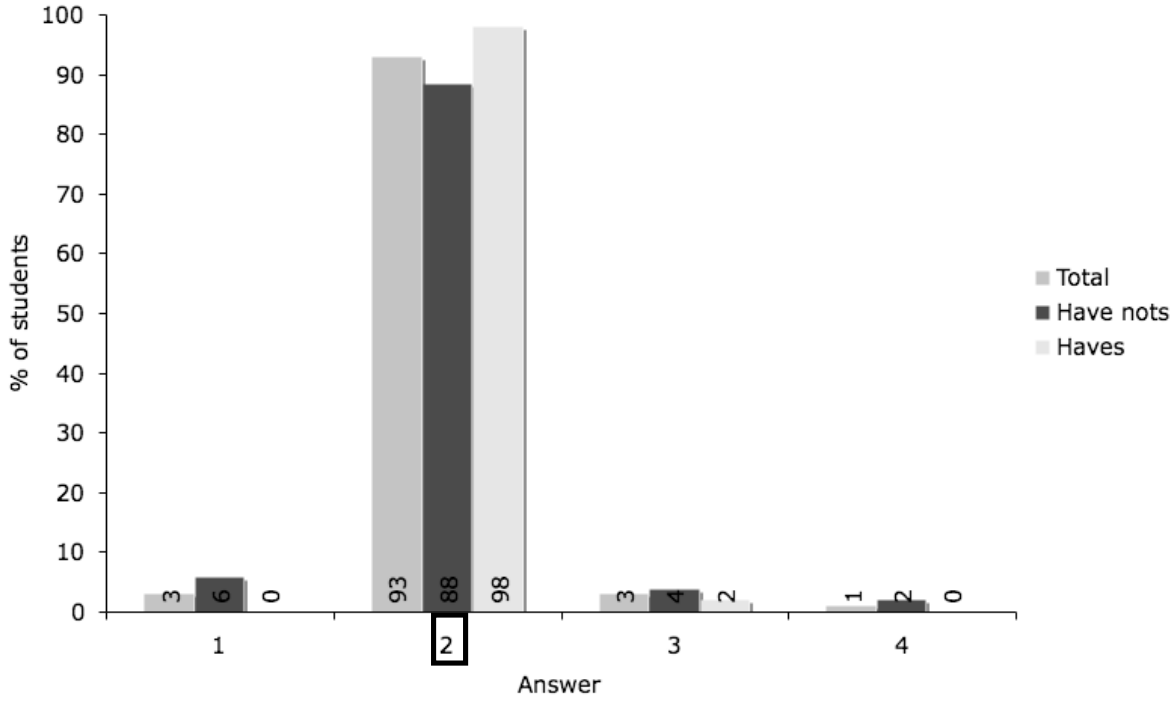

Figure 4 Response distribution for question 1

Figures 4–7 illustrate responses to the questions asked following the second podcast (Figure 2). Question 1 was straightforward, requiring a pre-University level of conceptual understanding of circular motion. The results confirm that the vast majority of the students chose the correct answer. In the case of those students who had earlier heard the podcast, practically this entire group (98%) chose the correct answer.

Question 2 addressed a commonly-held misconception about angular momentum. What is particularly interesting in Figure 5, is that not only do a slightly larger proportion of those students who had the podcast choose the correct answer (item 2), appreciably fewer chose the "classic" incorrect answer (item 1), which is indicative of a fundamental misunderstanding, which can be paraphrased as "only things moving in a circle have angular momentum".

The observed trend of slightly more "haves" than "have nots" choosing the correct response is again seen in the responses to questions 3 and 4, illustrated in Figures 6 and 7, respectively. The differences in number of correct responses are somewhat marginal, with the fourth question attracting a larger proportion of incorrect answers than the third, despite the fact it is essentially the same question.

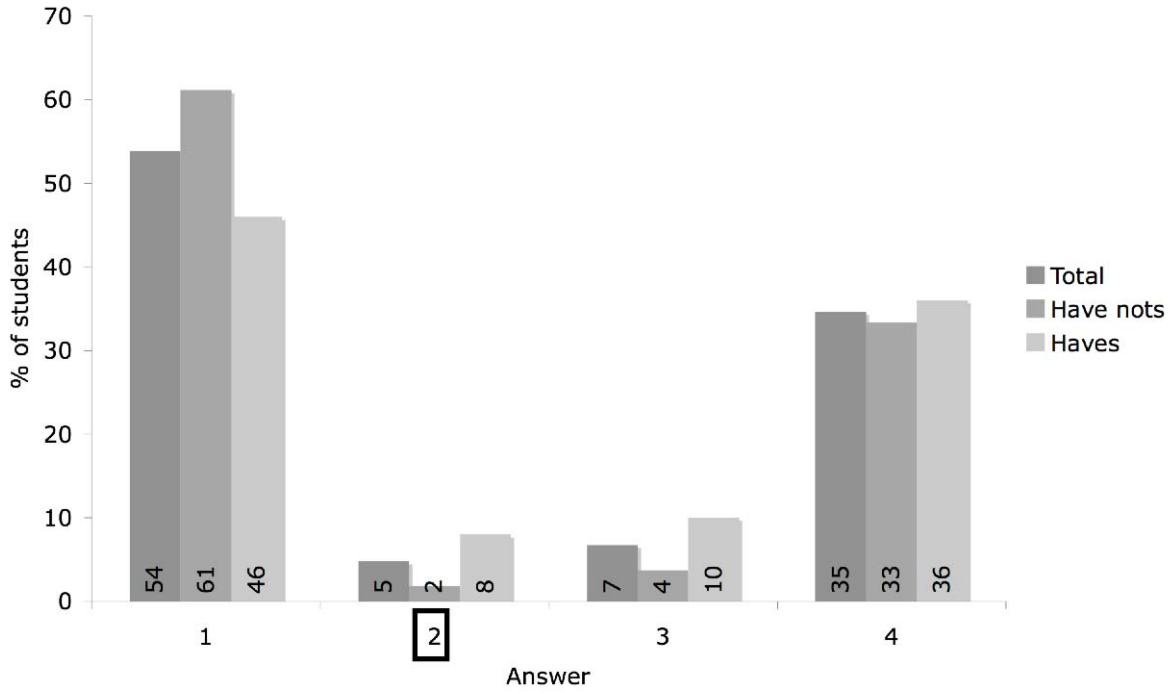

Figure 5 Response distribution for question 2

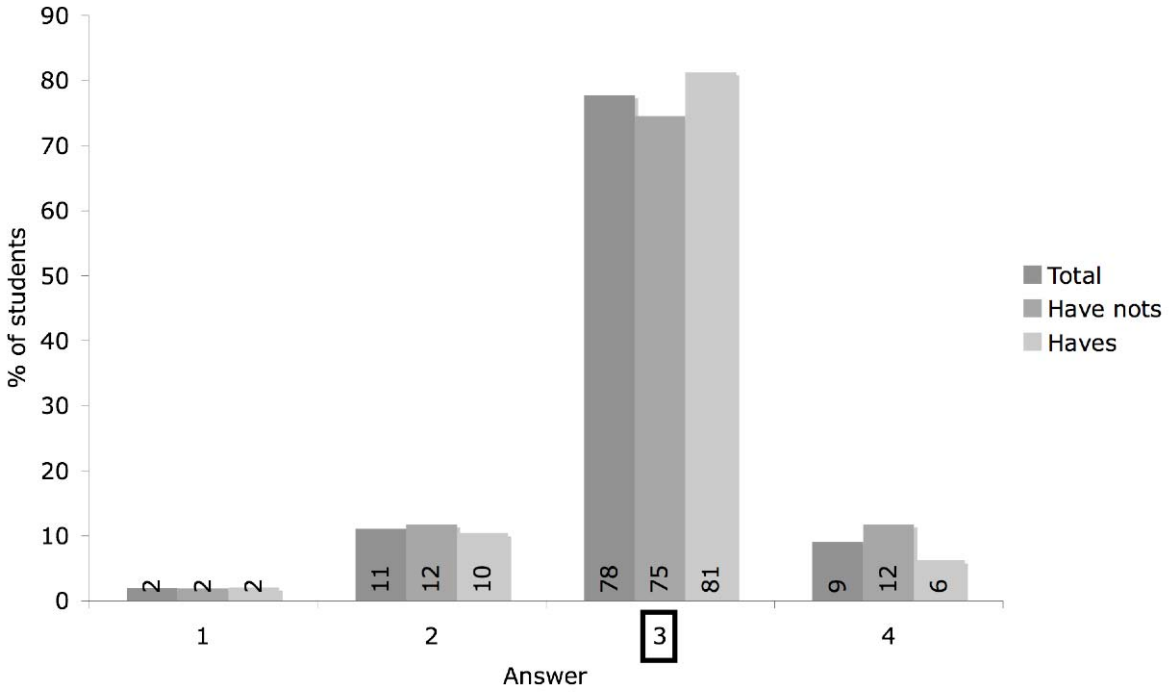

Figure 6 Response distribution for question 3

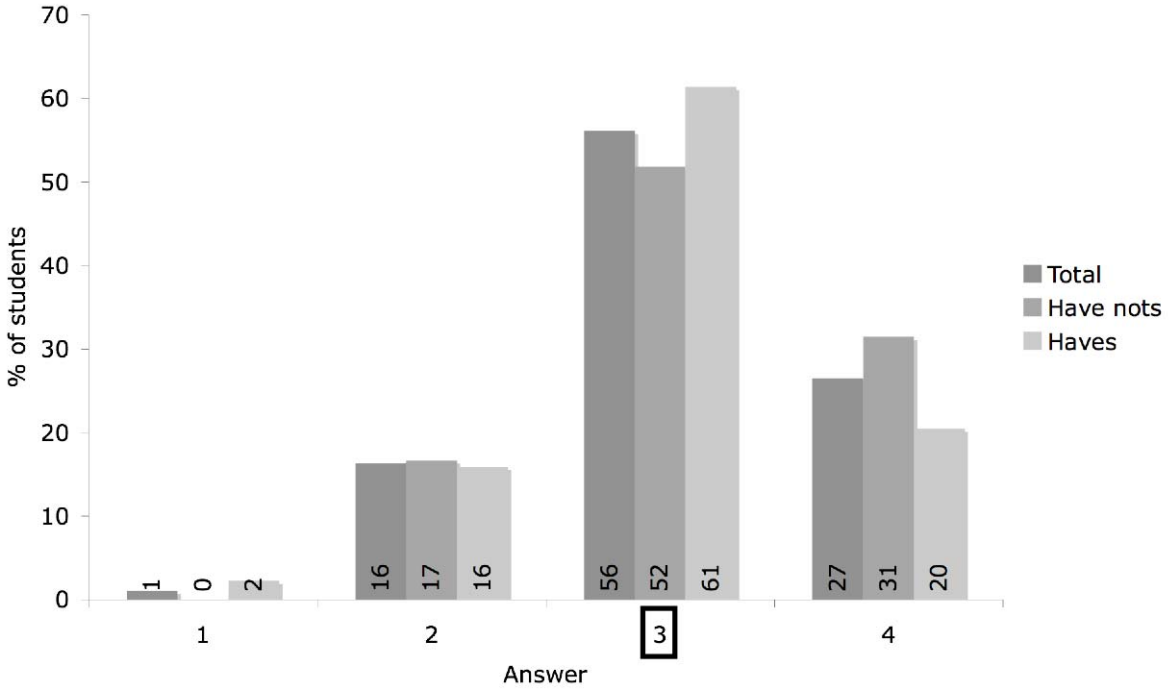

Figure 7 Response distribution for question 4

In assessing the response distributions of all four questions collectively, there is a consistent, if small, trend. In each case, approximately 10% more of the 'haves' get the correct answer than the 'have nots'. To further investigate this, we have calculated the number of correct

answers for each student from the set of four angular momentum questions used after the second podcast. The resulting histogram is shown in Figure 8.

The distributions are similar, with a slight shift of that for the “haves” to a higher number of correct questions. This is reflected in the mean number of correct answers. For the group of students having not had the podcast it was 1.9, for those who had it was 2.2. The results should not be over-interpreted though; both distributions have large standard deviations and a Student T-test does not indicate any statistically significant difference between them (~60% confidence level).

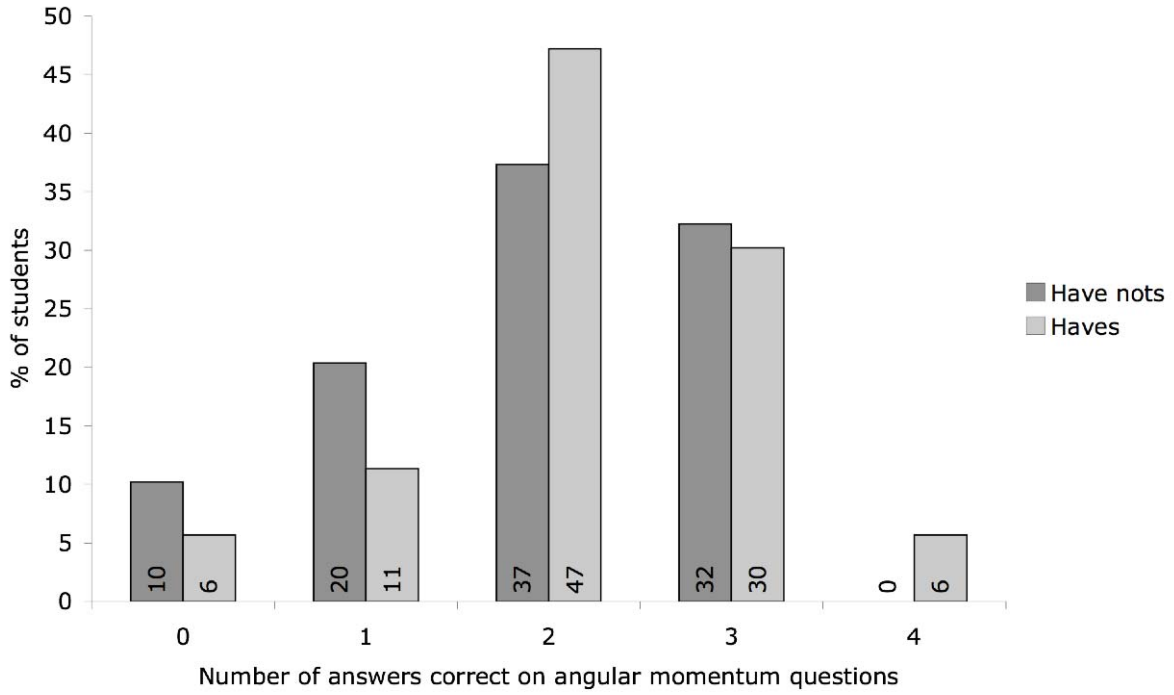

Figure 8 Number of correct responses for angular momentum questions

Evaluation

Evaluating the impact of these podcasts, it seems fair to say that the effectiveness of the podcasts seemed to increase when the content was more directed and as our own experience of authoring and integrating them within the course developed. This will be used to guide and inform future developments. We had, and in some respects continue to have, reservations about whether podcasting is the best way to approach conveying concepts in physics, an inherently visual subject. Newer hardware can incorporate pictures and video into podcasting (current generation audio devices can display pictures on-screen at certain points during the audio file and vodcasting is becoming more and more popular as broadband availability increases). However, this relies on students having appropriate technology and also makes the production process more complicated. A number of studies into distribution media say that, pedagogically, using audio and visual content at the same time could cause more problems than it solves. Forsythe (1970) states that

> *“In many educational situations visuals may be more harmful than helpful. Also the efficiency of combined audio and visual media has been challenged by studies which show that multi-channel communications may not be inherently more effective than single channel presentations.”*

Chu (1967) also found that the use of images improves learning of manual tasks, but for other subjects, they may distract from the audio content too much.

As well as gathering data on student understanding of the material as evidenced by responses to questions during the lecture, we included questions on the podcasts in the end-of-course questionnaires (113 students completed the questionnaire online). In addition to the podcasts delivered as described here, we also provided three during the course as purely supplementary information. These covered initial aspects of course housekeeping and studying at University, making the most of lectures and workshops, and advice on preparation for examinations at the end of the course. Second year students who had taken the course in the previous year were included as “voices” in the podcasts, as a way of helping listeners to relate to the people presenting the material (McLoughlin, 2006). Student responses to these podcasts were mixed, with approximately half the students who responded to the questionnaire stating they had not listened to them. A significant number of these indicated problems with technology (“no internet connection”, “couldn’t get them to work”) and issues with them not suiting their preferred learning style (“prefer visuals”, “used a textbook”, “plenty of other resources available online”). Several comments stated they would have preferred images and / or video in addition to the audio. Balancing this were positive comments about their usefulness, particularly the one on exam and revision strategies. The course has, as previously stated, a well-developed online presence, with a wide range of resources deployed to aid student self-study outside formal class hours (Bates, 2005). It may well have seemed to students that the three podcasts provided for information only were not sufficiently coupled to, or integrated with, the course itself.

Conclusion

This study has investigated the use of podcasts to provide prior exposure to conceptually-difficult material to students, in order to aid understanding. Additionally, we have attempted to gauge something more than simply the attidudinal or qualitative effects of providing material in this format. This was facilitated by capturing student responses to in-lecture questions using a electronic voting system. The second podcast episode, designed in part with help from the failings of the first, showed an encouraging trend. Consistently, across four questions based around the topic of rotational motion, we found a slight majority of correct answers in the group of students exposed to the podcast. Whilst not statistically significant, it gives us encouragement to learn from and build on these developments.

We do not claim to have quantitatively demonstrated the unequivocal effectiveness of podcasts in improving conceptual understanding. In some ways, we had set ourselves high targets that mitigated against this. We were using only audio in a subject where exposition via diagrams, sketches and mathematics are believed to be essential to its successful teaching. We were aiming to target and address widely-held misconceptions which have confounded large proportions (sometimes, all) of previous cohorts. Finally, we had no previous experience of writing, producing or delivering such material for maximum effectiveness, and learned a great deal on-the-fly.

The subject-specific dimension to all of this is significant. Undergraduate science curricula have traditionally aimed to cover the breadth of a rapidly-expanding body of knowledge, becoming obsessed with content coverage. (This can have obvious implications in the trade off between breadth and depth of learning, and may direct students towards a surface approach to learning). An Institute of Physics report (IoP, 1990, sec 3.2) has highlighted these problems, and a more recent one (IoP, 2001) has hinted these have been less than adequately addressed. The role of podcasts in such courses needs to be carefully considered; whether or not they are providing supplementary (or simply optional) material, or rather whether they are essential for the course week-to-week, as the only medium through which dissemination of information, activities or tasks for students is provided.

The present study has suggested that for future use of podcasts to support student learning, we should ensure they are (i) targeted to the relevant course material; (ii) structured in a logical and engaging way; and (iii) possibly incorporate visuals to concretize the concepts being discussed. We recognize that we have artificially constrained the learning opportunities within this experiment, by broadcasting episodes, rather than letting students choose an effective way to use them within their learning. Future work will build from this point, utilizing refined, targeted podcast material that will be available to students to use on elective basis. We will then have the option of (a) following up patterns and styles of use qualitatively and in-depth with some students and / or (b) designing an assessment to be taken by all students (to once again gather quantitative data) but be able to discriminate between those who did and did not elect to use the podcasts (e.g. by asking that very thing as the first question on the assessment).

The future use of emergent technologies in educational contexts seems set to develop apace. But this should not be because it is the latest fashionable "thing" to do. The aim, to quote Millar (2001, p289) should be to engage the learner;

> *"Science should be taught in whatever way is most likely to engage the active involvement of learners and make them feel willing to take on the serious intellectual work of reconstructing meaning".*

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PAPER 1160

Student perceptions of podcasting to enhance learning and teaching in an information systems course

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Abstract

Universities are challenged to seek methods to improve student learning. Leading edge technologies, such as podcasts, that put the focus on learner-chosen activities may be one way to accomplish this. This study explored student perceptions of podcasting as a learning and teaching tool in a first semester information systems course within an Australian university. Students were provided with a short podcast to supplement face-to-face lectures. Students were then surveyed to determine their perceptions of the impact of this podcast on their learning. A high number of respondents agreed that they used the podcast, that it increased their understanding of the lecture material and that it assisted their learning in the unit overall. The findings in this preliminary study lend support to the concept that podcasting can enhance learning when used as a supplement to traditional teaching methods.

Introduction

Universities are constantly searching for new methods to improve student learning. Podcasting is a popular internet-based technology enabling the delivery of both audio and video multimedia. This technology has the potential to enhance the learning experiences of an increasingly diverse student population. To enable teachers and learners to make the best use of podcasting in an educational context, there is a need to better understand how students perceive the use of this technology. It is also necessary to establish whether demographics such as age and cultural background have any impact on such perceptions.

The purpose of this research was to ascertain the perceptions of university students toward podcasting as a teaching and learning tool within an introductory information systems course at an Australian university. Using a survey developed for this purpose, the aim of the research was to determine how respondents engaged with the technology in order to assist with their learning in the unit. The study identified which parts of this technology assisted them in learning the content and to what extent. Understanding these student perceptions can lead to more effective uses of podcasting by teaching professionals in the future. The establishment of student interest in podcasting through this preliminary study will determine the direction of future research into the use of podcasting and other emerging technologies.

Mobile learning

Compared to that of previous generations, there has been a change in attitudes and learning styles among university students (Taylor and Eustis, 2006). These evolving characteristics pose a challenge to higher education institutions as students are reported to be 'less-engaged' in the traditional learning process (Genrich, Roberts, Cater-Steel, Low, 2004). Technologies which are already popular within the student population, such as mp3 players, are starting to gain momentum within education (Campbell, 2005). Since the inception of the podcast in 1994, a number of universities worldwide have introduced podcasts as potential learning and teaching tools. In Australia, Charles Sturt University is using podcasting to alleviate on-campus students' preconceptions and anxiety around lectures (Chan and Lee, 2005) as well as to enhance distance education students' integration into the learning environment (Lee and Chan, 2007). Lecturers at the RMIT School of Medical Sciences have used podcasts of lectures to give students an opportunity to review lecture content or listen to a lecture they may have missed (Laing, Wootton, and Irons, 2006).

Podcasting is a means of delivering multimedia content in an easy and direct manner (Campbell, 2005). Podcasting allows users to subscribe to a feed to automatically download new files as they become available. There is normally no cost associated in subscribing to a Podcast, which once downloaded can be played directly on the computer through a program such as Apple's iTunes. The format of a Podcast allows for easy download from a computer to an Mp3 player such as an iPod (Abram, 2006).

Podcasting is well situated to provide self-paced, 'anywhere-anytime' learning, and is well-matched to current students (Philpot, 2006). The tendency for students to be more independent learners and an increasingly diverse student population, has brought call for technology such as podcasting to be introduced into higher education (Taylor and Eustis, 2005). The current generation of university students appear to be more technologically minded, with fast uptake of mobile phones and Mp3 players (Huntley, 2006). Educators are now looking to this technology to meet this generation of students half-way (Lee, 2005).

Podcasting is a technology that falls into the category of what educators are describing as eLearning 2.0 (Downes, 2005). These eLearning 2.0 technologies result from the phenomenal growth of online learning and emerging technologies and includes technologies such as podcasting, blogs, and Wikis to name a few. The defining characteristic of eLearning 2.0 technologies is the ability of the learner to create content, collaborate, and take advantage of a variety of sources of content for learning. This ability of the student to take advantage of many sources of content meshes with the constructivist theory of learning that promotes the concept of learners constructing their own knowledge from a variety of teacher-supported learning options (Bednar, Cunningham, Duffy, and Perry, 1995). This self-directed theory of learning seems to fit today's mobile, independent student, and podcasting becomes another way for these students to initiate their own learning.

Chan and Lee (2005) in their exploration of podcasting to alleviate pre-class anxiety amongst undergraduate information technology students, found that podcasting combined the strengths of audio learning and 'anywhere anytime learning'. Abram (2006) explained the success of podcasting as a learning tool as related to the alignment of teaching and learning methods to student's natural behaviours rather than forcing unknown technologies or methods onto them. Genrich, Roberts, Cater-Steel, Low (2004) stated that part of a successful strategy to target university students would use mobile and internet technology familiar to this cohort.

The study

The investigation into the perceived effectiveness of podcasting as an enhancement to the current learning experience was conducted using a web-based quantitative survey. A quantitative survey style was chosen over qualitative methods such as interviews, because, although the data collected using qualitative approaches, such as interviews, would have been very rich, it was considered more important to capture the perceptions of a larger sample audience. A web-based survey is more anonymous and less threatening to students. In addition, the cultural diversity of students within the course may have made communicating effectively in an interview situation difficult.

Students were advised about the project in July 2006, during the first lecture of an information systems course. Students, comprised of both undergraduate and postgraduate levels, received access to a regularly updated podcast each week throughout the semester. These podcast included discussions of key concepts from each lecture, using 'bite-sized' episodes ranging between 5 and10 minutes in length. Students were expected to use the podcast to re-visit weeks they were less comfortable with or for general revision and exam preparation.

During mid-semester, September 2006, each of the 44 students enrolled in the course received an email with an invitation to complete a web-based survey about the podcast that had been made available. The survey was comprised of a number of demographic questions as well as closed likert style questions. One open-ended question was included at the end of the survey. A total of 41 students completed the survey. The results from this survey were measured and discussed against the questions below:

1. Do students use educational podcasts if they're made available to them?
2. Do students feel that the podcast assisted them in learning the content for the unit?
3. Do students feel that podcasting can enhance their educational experience within university education?
4. How do demographics such as gender, ethnicity and age affect the perceptions of students toward podcasting as enhancement of their educational experience?

Closed survey questions were analysed using frequencies and descriptive statistics to determine the level to which the respondents perceived the technology as helpful in their studies in the unit. Results were analysed to determine correlations that may have existed between respondent demographics and survey responses.

Results

This section presents the results of the data in response to the questions presented above. For purposes of brevity, only the closed questions and demographics from the survey are discussed in this article. For each question, relevant statistical data is presented. When describing the statistical evidence, percentages are rounded to the nearest whole number.

Use of educational podcasts

Respondents were asked if they used the podcast episodes provided to them as part of the Business Information Systems course. 'Using the podcast' is defined as either subscribing to the podcast through a program such as iTunes, or listening to podcasts directly from the website. Respondents were also asked to rate ease of use. The second part of the question queried how the podcast was used by the respondents, whether the podcast was downloaded to a portable player, such as an iPod. The availability of these devices to students was also explored.

Of the 41 respondents, 98% used the podcast made available to them. This implies a high degree of interest in the content and/or the technology.

To determine how respondents used the podcast, a question regarding perceived ease in accessing the podcast was asked, to which 88% of respondents agreed or strongly agreed that the podcast was easy to access. Table 1 below illustrates that the survey response to this question shows a difference in how strongly respondents agreed with the statement. Only a small number of students disagreed that accessing the podcast was easy.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Accessing the podcast was easy	5	0	7	54	34

Table 1 Percentage of respondents—ease of access

Table 2 below indicates that of 41 respondents, 66% had access to a portable player or PDA device or both. Only 31% of students did not have access to any sort of portable player.

	Percent
Has access to PDA	15
Has access to portable MP3 player	46
Has Both PDA and MP3 device	5
Has neither	34

Table 2 Access to a portable player

How students used the podcast once they gained access was also queried. When asked if they synchronised the podcast to a portable player 34% reported that they did, while 66% of respondents did not. This indicates a gap between those owning an MP3 compatible device and those choosing to use this device for the unit podcast.

Perceptions of podcasting as a learning tool

The data collected in this section establishes how the respondents perceived the podcast assisted them in learning the content for Business Information Systems. In addition, respondents were asked about their attitudes about the future use of podcasting within the university.

Table 3 shows responses to whether respondents believed lecture material was easier to understand due to the podcast episodes, if respondents perceive the podcast episodes assisted them in understanding course material, as well as how respondents felt about viewing the lecture material in their own time using the podcast. The data shows that most respondents (90%) agreed that lecture material understanding was increased. In total, 88% of respondents agreed that the podcast assisted them in their understanding of course material. When queried about their comfort in viewing lecture material in their own time using the podcast, 94% of respondents agreed.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The lecture material is easier to understand due to the podcast	2	0	7	46	44
The podcast assisted me in understanding material the course material for CP571	2	0	10	54	34
I feel more comfortable listening to lecture related material in my own time using the podcast	2	2	5	42	49

Table 3 Perceptions of assistance and comfort by percent

Table 4 below reports results from the survey relating to whether respondents believed podcasting has a future within university as a teaching and learning tool and if they would like to see other courses at the university offer podcasts. Most respondents (95%) agreed that podcasting has a future within the university as a learning and teaching tool. Respondents also agree strongly (90%) that they would like to see other courses at the university utilize podcasts.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I feel podcasting has a future within the university as a teaching and learning tool	2	0	2	37	59
I would like to see other courses at the university offer a similar podcast	2	0	7	37	54

Table 4 Future as a teaching and learning tool—by percent

Enhancing students' educational experience

The aim of the next three questions was to determine respondents perceptions regarding the ability of the podcast to enhance their educational experience. To 'enhance education' is quite subjective and it is reasonably difficult to present evidence to support this claim. The questions in the survey are designed to indicate whether respondents felt the podcast had appropriate content, integrated well with course material and whether they felt it was an enjoyable way to learn.

Table 5 below shows that a total of 87% of respondents either agreed or strongly agreed that the podcast had appropriate content. Most respondents (93%) perceived that the podcast

integrated well with the existing material in the course. Finally, respondents were asked if they found the podcast an enjoyable way to learn course material. Again, 93% agreed that they enjoyed learning this way.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The podcast had appropriate content	2	0	10	63	24
The podcast integrated well with existing unit material	2	0	5	54	39
Listening to the podcast was an enjoyable way to learn more about CP571	2	0	5	49	44

Table 5 Percentage of respondents who perceived the podcast had appropriate content

Impact of demographics on student perceptions

The survey began with demographic questions to enable a profile of survey respondents to be developed. These questions were asked in order to establish whether there is any relationship between the perceptions of respondents toward podcasting and any of the demographic groups. Table 6 below shows a summary of respondent demographics.

Age	25 or under	76
	Over 25	24
Gender	Female	27
	Male	73
First Language	English	37
	Other	63
Origin	Domestic	22
	International	78

Table 6 Demographics of Respondents by percent

The four demographic groups were tested to establish any possible relationships between these groups and the responses on the nine perception questions in the survey. A number of statistical tests including Chi-Square testing, Fishers's exact tests and Mann-Whittney tests were completed on the demographic variables. No verifiable significant associations could be found between any demographic variables and the nine perception questions in the survey. For the sake of brevity, the results of these tests will not be presented in this paper.

Summary of results

This study explored the perceptions of university students toward podcasting as a teaching and learning tool, and whether these perceptions were affected by demographics such as age, gender, origin and English speaking background. Some of these perceptions included whether the podcasts assisted in learning course content, whether the podcasts were easy to use and whether learning course material through the podcasts was enjoyable. The level of participation from the potential survey population was high, and most respondents used the podcast. Respondents who used the podcasts were positive about the enhancement of their learning in the course as well as the future applicability of podcasting in learning course content.

The results of this study indicate that the demographics selected for this study do not appear to be associated with the overall perceptions of the podcasts. An analysis of both individual survey questions and overall perceptions found no difference in the way respondents answered questions based on demographics. This result may be impacted by the small sample size used for this study, as well as the survey population being restricted to one course within the university.

Discussion

Introduction

The purpose of this study was to investigate the perceptions of university students regarding podcasting as a teaching and learning tool. A convenience sample of undergraduate and postgraduate level students enrolled in an introductory information systems course were surveyed about the educational podcasts they had received that semester. This exploratory study used a self report survey to collect quantitative data. This section presents a summary of results and discussion of findings for each research question along with relevant literature in that area. The final section of this paper includes limitations of the study, suggestions for future research, and concluding remarks.

Student's use of the educational podcast

This research question aimed to determine whether university students would use educational podcasts if they were made available to them. This question also explores how students would use the podcast. As shown in Table 1, 98% of respondents accessed the podcast, indicating that most students would access an educational podcast if one was made available to them. In addition, 88% of respondents agreed or strongly agreed that accessing the podcast was easy. Interestingly the findings also show that many students who had access to a portable player did not synchronise the podcast to their portable player.

The research on podcasting as a teaching and learning tool is still in the early stages. However, the relevant literature suggests that podcasting had been positively received and that further research is warranted into its use as a teaching and learning tool within universities. Several studies are currently in place to study the impact, advantages and pedagogies of podcasting within higher education, including a large, multi-university project in the United Kingdom (Beyond Distance Research Alliance, 2007). Studies at Duke University (Earp et al., 2006), found that university students accessed an educational podcast offered as part of the Duke Digital Initiative, and research by Chan and Lee (2005) at an Australian university found over 95% of university students indicated that they would access an educational podcast if they were given the opportunity. The results of this study parallel these views and other literature, that in a university setting students readily accessed and used educational podcasts when they were given the opportunity.

The results of the study indicate that respondents found accessing the podcast easy and that most respondents already owned a PDA or mobile MP3 player device which could be used to play the podcast. It should be noted that even though most respondents had a mobile device, many chose not to use this device to listen to the podcasts. This indicates that although many students would view the podcast on their PC, they may not also choose to use their mobile device for listening. Lee (2005) stated that by leveraging familiar technology it is possible to further the cause of learning and create mobile-learning. The results of the study do not indicate exactly why students did not all use their device for mobile learning. Some possible reasons could be that students had technical difficulties, or perhaps students did not perceive podcasting was a suitable avenue for mobile learning. As it is unclear, this may be an area which should be investigated in future research.

Overall the results suggested that university students would use educational podcasts if they were given the opportunity, and that students would probably find accessing that podcast easy. The results showed that most university students have access to a mobile device to allow for mobile learning but some may not necessarily take the opportunity to utilise this device for that purpose.

Perception of learning assistance from podcasts

This research question aims to determine whether university students perceive that the podcast assisted them in learning course content. Part of that aim was to explore whether students felt more comfortable viewing course material in their own time. The research question also attempted to determine whether students believed that educational podcasting has a future within the university in general and whether students would like to see educational podcasts being offered within other courses at the university.

The results indicated that a majority of respondents agreed that podcasts assisted them in learning course content. The results also indicated that students perceived that the podcast assisted them in understanding lecture material. Student views regarding the future of podcasting as a teaching and learning tool at the university was found to be positive. As shown in Table 4, most respondents believed that podcasting has a future at the university and would like to see podcasting offered in other courses at the university. Overall the responses from the survey indicated that respondents perceived that the podcasts assisted them to learn the course content and understand lecture material.

The research on mobile and internet technologies as teaching and learning tools is still in the early stages. However, literature reviewed did suggest that technologies which are familiar to university students such as podcasting may be well received as teaching and learning tools. A number of studies have found students receptive to the idea of podcasting as a learning tool (Chan and Lee, 2005; Duke, 2004; Earp, Belanger, O'Brien, 2006). Further investigation using a variety of learning strategies with podcasting will further illuminate student interest and outcomes when using this technology for learning.

The findings of this study indicated that university students perceived that podcasting assists them to learn course content and understand lecture material. The present findings are consistent with those by Glenn (2003) who also found that technologies gave students more freedom over the learning environment would be well received by students. According to Glenn (2003) podcasting was likely to have been well received by students because of the apparent increased control over the learning environment and findings here are consistent with that.

The results of the present study support the findings in research from Genrich et al. (2004). The study (Genrich et al., 2004) used a strategy to target current student learning behaviours using mobile and internet technologies which were familiar to students. The present study built on this research by using familiar technology, and the results suggest that students did

perceive that podcasting helped them to understand course content and lectures. The present study also found that students believed podcasting has a future as a teaching and learning tool and that most would like to see podcasting offered in other units. This is related to the findings of Taylor and Eustis (2002) which stated the use of technology may remedy the learning needs of an increasingly diverse student population. The results of the present study support views of Taylor and Eustis (2002) that indicated that by using technology to advance the teaching and learning methods offered by the university it may better meet the learning preferences and expectations of students.

The results of the study may indicate that university students are able to learn more effectively through the use of a podcasting which supplements the traditional methods already offered by universities. Future research that includes pre and post measures of academic achievement together with a control group would increase confidence that the inclusion of podcasting as a teaching and learning tool aids overall enhancement of learning.

Perceptions of enhanced learning from podcasts

This question explored whether students perceived the podcasts enhanced their educational experience. Although it is difficult to measure student's perception that the podcast 'enhances' their education, three areas were measured to provide evidence which may support an answer this question. These include whether students perceived the podcast had appropriate content, integrated well with existing course material and was an enjoyable way to learn.

The results of the present study indicated that students perceived that the podcast had appropriate content. As shown in Table 5, 88% of respondents agreed or strongly agreed that the podcasts had appropriate content. The results show that 93% of respondents agreed or strongly agreed that the podcasts integrated well with existing course material. Table 5 also shows that students found the podcast an enjoyable way to learn course material, as 93% of respondent agreed or strongly agreed with the statement.

In summary, the results suggest that students perceived that the podcasts had appropriate content, which integrated well with existing unit material, and was an enjoyable way to learn about the course. Overall these results indicate that students reacted positively to podcasting as an enhancement to their learning.

Although the present study did not include a control group, or pre and post measures of academic performance, by self report, the majority of respondents indicated the podcast enhanced their educational experience. These findings are consistent with earlier research at Duke University which also found their educational podcasts were perceived to be helpful by students (Duke, 2004). Research by Walker et al. (2006) found resistance to the notion of web-based learning replacing traditional teaching and learning methods (Walker et al., 2006). This literature may suggest that the present study was successful because it did not remove the existing teaching and learning methods. Further to this, the results are indicative that university students overall perceived the podcasts to be valuable learning aids.

The respondents in this study have indicated that the podcasts they received as part of an information systems course were seen as valuable tools in learning the unit content and understanding lectures. This evidence suggests that by introducing similar podcasts into other courses these podcasts may also be perceived positively by students and may enhance learning.

Respondent demographics and the potential impact on perceptions

This question considered the degree to which specific demographics were associated with perceptions of the educational podcasts. The results of this study indicate that none of the

demographics selected for this study appear to be associated with any of the nine perception questions asked in the survey. This was demonstrated using a non-parametric test which found no overall association between the demographics and how the respondents answered the questions. This was also demonstrated through the Chi-square and Fisher's exact tests on individual survey questions which did not find any significant relationships.

The overall percentage of students from each generation reflected the balance shown in the literature. However, this study differed from the literature, which found the majority of current university students under 25 indicated they communicated differently to previous generations, and that males preferred internet communication over females ((Genrich et al. 2004; Wolburg and Pokrywczynski, 2001). The current study contradicted these findings as there was no significant difference found in how students perceived the podcast, based on either the generation or gender of the student. The small size of the respondent pool may be influencing these findings however. Replication of this study using a larger university population would be necessary to verify this result.

A study by Harman (2004) states that there were increasing numbers of international students studying at Australian universities. In this study 73% of responders were international students and 63% did not use English as their first language. The results of this study did not find the students origin or their language background negatively impacting their perceptions of the podcast. In fact, comments from international respondents indicated that the podcasts were especially helpful for revisiting the lecture material and adding to notes for the class.

As an exploratory study, there was not a large sample size for this research. The lack of findings in relation to significance between the perceptions of the podcasts and the demographic groups may be due to this small sample size. A larger sample size may provide further evidence as to whether there is any relationship between student demographics and perceptions of podcasting as a teaching and learning tool.

Limitations of study and future research

One of the major limitations recognised for this study was the use of self-administered surveys. It is acknowledged that there are certain difficulties associated with the use of self-administered surveys, such as the lack of control by the researcher in the environment where the respondent completes the survey. Respondents were encouraged to complete the surveys by using a relatively short survey. It is also recognized that a major limitation of the study was the size of the sample population which may mean the results do not necessarily generalise to all Australian university students. For example, this particular cohort may be more technically adept then students studying other disciplines.

Future research across a broader range of courses using a larger sample size may increase confidence that podcasting would be perceived as helpful by all university students. Further research should aim to determine the hourly commitments students have outside university contact hours. This may provide an association between receptiveness to mobile learning and student time demands. Further research may also attempt to link the use of podcasting in courses to student's academic performance using pre and post measures of student academic results in the course. Further research designed to examine whether successful use of podcasting in learning and teaching results from the content of the podcast or the technology used is seen as critical.

A critical area future research is the establishment of a link between theories of learning, the development of teaching models, and technologies such as podcasting. Larger studies, such as IMPALA, can develop a considered direction for this and other technology tools to create the greatest possible impact on student learning.

Conclusion

The results of this preliminary study informs the researchers as well as the field of practise regarding the use of podcasting in an educational environment. Methods of podcasting as well as the perceptions of students regarding the ease of use and benefits of this technology will allow for the development of curriculum around the concept of podcasting as a viable and valuable learning and teaching tool. Further studies into the use of podcasting in different areas of study other than information systems, as well as best practise models for the university are being considered since the conclusion of this first study.

The evidence from the present study indicated that university students perceive podcasting positively as an educational teaching and learning tool. After receiving the podcast for the first seven weeks of the semester, students stated they were able to learn course content and understand lecture material more easily. This suggests that university students would view podcasting as a valuable addition to traditional teaching and learning methods. This use of additional learning tools is supported within contructivist learning theory.

This study endeavoured to find a relationship between the perception of the podcast and demographics such as age, gender, origin and language background. It was expected that student perceptions would differ based on their demographics such as their generation. However, the results of the analysis did not confirm any association. From this study, it is clear that further research with a larger cohort is required to identify whether there is an association between student perceptions of podcasting and demographic groups.

The findings of this research indicate that this group of university students perceived that educational podcasting has a future within university education. The findings indicated that these university students would react positively to the introduction of podcasting into other university courses, and that podcasting may assist to meet the learning preferences and expectations of this diverse student cohort. These results, coupled with other areas within the e-learning 2.0 spectrum can contribute to higher education learning and teaching by enabling students to construct content that assists their learning from a variety of sources, of which podcasting is just one. Further studies into this area can assist in the production of useful, viable learning tools for students, backed by the development of sound educational theory surrounding these tools.

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Knowledge creation processes of students as producers of audio learning objects

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Abstract

This paper reports on a study aimed at investigating the learning and knowledge construction processes of volunteer university students tasked with producing short, talkback radio-style educational audio learning objects (Middleton and McCarter, 2006; Cebeci and Tekdal, 2006), to be distributed to cohorts of other students through podcasting technology. The study used focus group interviewing to analyse the cognitive and social interaction that occurred as students engaged in developing the joint objects of activity. The findings indicate that both individual and collective advances were achieved through collaborative dialogue and peer-to-peer interaction. In addition, the metacognitive processes of planning, self-monitoring and reflection were evidenced in the student-producers' discourse.

Background and introduction

Podcasting (Curry, 2004) allows audio content from one or more user selected feeds (channels) to be automatically downloaded to one's computer as it becomes available, and later transferred to a portable player for consumption at a convenient time and place. There has been significant uptake of portable music players and podcasting, both in mainstream society as well as in all sectors of the education industry. In addition to myriad possibilities for

flexible and distance education, podcasting can enhance learning in face-to-face and blended environments by engaging students in the material and adding yet another modality of learning (Carson, 2006).

Schlosser (2006) reminds us that "[t]he use of audio in education is not new, but is experiencing a renaissance fuelled by the ubiquity of portable audio players, broadband Internet, and software tools that allow the relatively easy creation and distribution of audio files" (sec. 2, para. 1). While many existing uses of podcasting in higher education focus on the use of the technology to deliver instructional content such as lectures, the authors of the present paper believe its potential lies in its collaborative and team building value through encouraging dialogue and interaction amongst learners, and its use as a vehicle for disseminating content generated by the learners themselves. This view is echoed by both Miller (2006) and Atkinson (2006), the latter of who believes that podcasting has limited impact as a mere method of distribution and that "The emerging developmental and research direction seems… to be learning through *creating* podcasts and similar, in contrast to learning *from* podcasts" (p. 21, emphasis in original).

The authors' own foray into educational podcasting first began as an attempt to use pre-class listening material to address the anxiety and preconceptions of students studying an undergraduate information technology unit at the Wagga Wagga campus of Charles Sturt University (CSU) (Chan and Lee, 2005). The scope of the project has since expanded dramatically to encompass other units, involving undergraduate and postgraduate students in both IT as well as other disciplines, studying at one of CSU's regional campuses as well as off-campus in various locations around Australia and overseas.

The authors' podcasting approach is centred around 3 to 5 minute talkback radio-style "shows", in which two or more students participate in informal discussions on pertinent issues related to the relevant unit and its content. The podcast production process is driven entirely by a group of volunteer students, with minimal intervention from their lecturer. The study described in the present paper sought to investigate the knowledge building and construction processes that these student-producers engaged in as they worked individually as well as collaboratively as a team, in addition to examining the levels of reflection and metacognition that occurred as a result of their participation in the exercise. The study is an example of how tangible learning outcomes are resulting from the growing adoption of Web 2.0 (O'Reilly, 2005) applications in university teaching and learning across Australia. The views and experiences of the student-listeners, and the impact of the podcasts on these students, form the topic of a number of other publications (for example, see Lee, Chan and McLoughlin, 2006; Lee and Chan, 2007; McLoughlin, Lee and Chan, 2007).

Digital Audio Learning Objects (DALOs)

The design of the podcasts in the present study is consistent with the Digital Audio Learning Objects (DALO) (Middleton and McCarter, 2006) concept, which combines reusable learning object theory with theory pertaining to the pedagogically sound use of digital audio to enhance e-learning. Learning objects have been the subject of much discussion and research for a number of years (Wiley, 2002). Although much effort has been expended in the development of learning object standards, implementations and applications, the volume of learning object content remains limited. Because of its relative simplicity when compared with other forms of multimedia, digital audio offers great promise for producing and enriching learning objects. Cebeci and Tekdal (2006) also advocate using podcasts as learning objects, and propose the development of measures to allow them to be easily used in conjunction with existing learning management systems and learning object repositories.

A DALO is defined as "A digital audio file that can be used, and reused, in various learning situations and that supports a distinct learning objective using an appropriate and engaging

method" (Middleton and McCarter, 2006, p. 7). The key features of a well-designed DALO are: *simple to produce*, *immediate*, *educationally focussed*, *reusable* and *engaging* (Digital Audio Learning Objects, 2007).

The student-producers: teamwork and production processes

At the time of the study, the student-producers team consisted of eight volunteer members, of which five (three females and two males) participated in the research data collection process. Three of the participants were enrolled in the Bachelor of Information Technology degree, while the remaining two were enrolled in double degrees combining the Bachelor of Information Technology with a Bachelor of Business and a Bachelor of Teaching (Secondary), respectively.

Most of the team members were recruited at the end of their first semester at the university. They expressed an interest in participating, following an announcement and brief overview of the project by their lecturer in class. During each semester, the group met on a weekly basis, which was reduced to a frequency of once a fortnight as the semester progressed and their own study workload increased. The meetings were structured though relaxed, lasting for a duration of approximately one and a half hours each.

The student-producers brought to the team varying levels of knowledge and skill, and different sets of backgrounds and experiences. They were not provided with any formal training, but rather were introduced to the script writing, editing and presentation process by means of examples. They gradually developed competence in the various facets of the process through undergoing a number of practice runs, with decreasing levels of guidance and scaffolding, as well as through their interactions with one another. Many of them also familiarised themselves with digital audio recording and editing tools, as well as web technology as it applies to podcasting, through self-directed research and reading in their own time.

Podcast production process

The podcast production process followed by the student-producers consisted of four stages, described below.

Scriptwriting and editing

The student-producers were proactive and self-regulated in their work. They brainstormed, discussed and debated ideas for the podcast scripts during their meetings, with the lecturer providing advice and guidance only upon request. A member of the team was responsible for documenting ideas for later follow-up. One or two members would typically take "ownership" of a particular script idea by agreeing to undertake the necessary research and to produce a draft script. Draft scripts were circulated amongst the group to provide opportunity for input from all members.

Presentation

Like the script writing and editing process, the casting of roles for each podcast episode was a team effort, with decisions made in a democratic manner. Members were familiar with one another's strengths and weaknesses, and through their participation in the many recording sessions, each was able to develop his/her own unique podcast "persona".

In preparing for a recording session, the presenter(s) had access to the full script. The team typically conducted one or more informal rehearsals, during which the script was tested and appropriate modifications made. Minor changes to wording and even swapping of roles often

occurred as a result of this testing, as did variations in logistics such as seating configurations and equipment setup. For the earlier episodes the rehearsals were also especially important as a confidence building exercise for the presenters.

During a recording session, scripts were used as a guide and were often subject to impromptu variation and improvisation at the discretion of the presenter(s), who tried to avoid simply reading the scripts verbatim so as to provide a more relaxed, natural feel.

Audio recording and editing

The presentations were recorded in waveform (WAV) format using basic recording equipment. Editing tasks included splicing or cutting out mistakes in the presentation, reducing the length of pauses or periods of silence and reducing the sound file size while maintaining an acceptable level of sound quality. The file was then exported into MP3 format for podcasting. Approximately 20 minutes of editing resulted in the production of one minute of finished audio.

Publishing and distribution

The platform used for publishing and distributing the finished podcasts was Charles Sturt University's proprietary Flexible Publishing system (Charles Sturt University, n. d.). To facilitate the project, the system was extended to allow MP3 files containing podcasts, along with their associated RSS 2.0 files (specifying the contents of the podcast feed), to be uploaded. This allowed members of the student audience to subscribe to the feeds using aggregator software to automate the downloading of new content, or alternatively to manually download the MP3 files via the online subject outline, using a standard web browser.

Knowledge building and creation

In today's knowledge society (Bereiter, 2002) there is a premium on the processes of creation, innovation and discovery, as these are the means by which social and cultural capital are increased. The concept of knowledge has attained increasingly complex meanings, combining expertise, concepts and skilled performance. This complexity is illustrated through the proliferation of concepts distinguishing between knowledge types, for example, situated and abstract forms of knowledge, and semantic, logical, empirical, systemic, procedural metacognitive and conditional knowledge. The multiplicities of knowledge are also reflected in an ever-broadening view of attributes and skills required of graduates, ranging from generic skills to domain knowledge coupled with a demand for hard core entrepreneurship and innovation (McLoughlin and Luca, 2006).

In planning for the educational application of technology, besides technical and social infrastructure, educators and designers need to consider the epistemological foundations of learning. Extant theories and models help to explain the role of different agents (for example, individuals, communities, networks) in knowledge creation, the mechanisms of knowledge advancement (for instance, how new ideas are generated and advanced), and processes of inquiry (such as the role of questions and activities to promote learning). Comparing models of knowledge construction and knowledge building communities affords a better understanding of the processes by which new knowledge is created in technology-supported learning environments. In order to provide theoretical and pedagogical grounding for research into podcasting and knowledge building, it is essential to consider current frameworks and metaphors of knowledge and learning.

Choosing a metaphor to describe learning through student-generated podcasts

Sfard (1998) distinguished between two metaphors of learning, the *acquisition* metaphor and the *participation* metaphor. The former represents the traditional view according to which learning is mainly a process of acquiring chunks of information, usually delivered by a teacher. This metaphor implies that learning is a matter of individual construction and acquisition; successful learning is characterised by a person's capability to use and apply knowledge in new situations. An alternative model, according to Sfard, is the participation metaphor of learning that perceives learning as a process of participating in various shared activities and practices. According to this metaphor, the focus is on activities, i.e., on learning to learn, and not so much on outcomes or products, i.e., on "knowledge" in the traditional sense. Knowledge does not exist in individual minds but is an aspect of participation in cultural practices (Brown, Collins and Duguid, 1989). Cognition and knowing are distributed over both individuals and their environments, and learning is situated in these relations and the activities undertaken by networks of distributed individuals. Within the participation metaphor, learning is a matter of participation in a social process of knowledge construction, often refered to as "enculturation", "guided participation" or "legitimate peripheral participation", all of which are based on the tenets of sociocultural theory (Vygotsky, 1978).

In order to develop a framework that would help one to understand innovative knowledge communities that are emerging in the knowledge society, it appears to be necessary to go beyond the acquisition and participation dichotomy. The present investigation utilises the *knowledge creation* metaphor of learning (Paavola and Hakkarainen, 2005), which builds on common elements of Bereiter's (2002) theory of knowledge building, Engeström's (1987, 1999) theory of expansive learning, and Nonaka and Takeuchi's (1995) model of knowledge creation. The knowledge creation metaphor appears to help to overcome the separation of the cognitive (the acquisition metaphor) and the situative (the participation metaphor) perspectives. Knowledge creation means that knowledge is emphasised, as in the acquisition and participation metaphor, but the processes involved are different: They are not merely dependent on situated action alone, but require participation in social interaction, knowledge building dialogue, and a focus on developing and creating knowledge. Learners and the social processes they engage in are foregrounded, as they are active participants in the creation of knowledge. They are not there to simply participate in activity and acquire skills, but also to produce shared outcomes and advance the intellectual capital of the group.

Recent research acknowledges the power and relevance of the knowledge creation metaphor in a knowledge-based society. The notion of creating shared knowledge objects through participation is precisely what Web 2.0-based learning is all about, and the expressions "user-generated content", "peers produce knowledge" and "users add value" are reminders that the social software tools in Web 2.0 can be used to facilitate knowledge creation activities that draw on the users and their knowledge, enabling collaboration and the creation of shared artefacts (e.g. audio learning objects / podcasts for sharing knowledge).

The study

Research aims/questions

The study sought to address the following research questions:

1 What indicators of *metacognitive and self-reflective processes* are present in the student-producers' discourse, when they discuss their experiences of creating audio learning objects for other students?

2 What *knowledge building features and processes* are evident in student-producers' reflective discourse?

Data collection procedures

Two focus group interviews were conducted over the course of 2006 to elicit the views and experiences of the student-producers, for the purpose of better understanding their knowledge creation processes. The first session was conducted immediately after the first series of podcasts was produced in order to elicit levels of metacognitive activity and awareness resulting from the team's experience. A list of questions was developed for the focus group session (Table 1). These questions were to be used as a guide; they were not intended to be followed to the letter.

No.	Question	Metacognitive element (White, 1999)
1	What are the major incentives / sources of motivation driving your interest in the project, especially given the fact that your participation is not rewarded through formal academic credit?	Self knowledge, self monitoring, understanding one's own motivation for involvement in the tasks
2	How did being involved in the scriptwriting, editing and presentation of the podcasts to support the topics in the unit of study benefit you? What did you learn from a subject content point of view? How about other generic knowledge and skills?	Task knowledge: Understanding the demands of the task and how engagement with tasks develops personal skills and knowledge
3	What lessons have you learnt from the project, that might form the basis of advice / recommendations for other educators and groups of student-producers pursuing similar projects?	Strategic knowledge: ability to see how strategies used in podcasting might benefit others
4	Do you have any further suggestions on how to make this a really good experience for all those involved (student-producers, lecturers, student-listeners)?	Knowledge of plans and goals; capacity to plan and project ideas, assess benefits for self and others and refine the task itself

Table 1 Focus group 1 questions, designed to investigate metacognitive components

In the second focus group, which took place after the conclusion of the academic year, questions and discussion centred around the outcomes and processes of the podcasting experience, and the student-producers' perceptions of the task in relation to knowledge building and creation.

Data analysis procedures

The content analysis of all focus group data collected for the study was conducted in four steps. Complete transcripts were first made from the audio tape recordings of each of the focus group sessions. To ensure anonymity, participants' real names were replaced with aliases during the transcription process. The next stage was to agree on a protocol for identifying and categorising the target variables, and training coders to use this protocol. In this case, two of the researchers undertook the coding task. The transcripts, in the form of

text files, were searched for verbal indicators of the themes and variables of interest. The unit of analysis chosen was the sentence or phrase. The instances found were collated, classified and then counted. Following independent coding, the two coders' decisions were compared to establish interrater reliability. The final stage was to combine the results of the coding process and report on the incidence of the target variables.

Analysis frameworks used and results

Research question 1: Metacognitive knowledge evidenced in discourse

Analysis framework. Metacognition is a learner's knowledge about his or her processes of cognition and the ability to control and monitor those processes as a function of the feedback the learner receives via outcomes of learning (cf. Metcalfe and Shimamura, 1994; Schraw 1998). Metacognitive knowledge refers to what the learner understands and believes about a subject matter or a task, and the judgments he or she makes in allocating cognitive resources as a result of that knowledge. White (1999) identified four categories of metacognitive knowledge, listed below, which are particularly useful in targeting the first research question:

1. *Self knowledge*—Self knowledge entails the individual's capacity to recognise his/her strengths and weaknesses and to him/herself;
2. *Task knowledge*—This involves understanding the demands of tasks and what they require;
3. *Strategic knowledge*—This refers to the learner's knowledge of the usefulness of strategies available for achieving learning goals;
4. *Knowledge of plans and goals* –This refers to the learner's capacity to set and maintain goals and to record what he/she intends to do through his/her learning.

There is considerable debate about the relative strengths of the different approaches to assessing metacognition (Shraw and Impara, 2005). While there are several instruments that measure metacognition, each of these was deemed to have limitations, rendering them unsuitable for the present study. For example, the *Index of Reading Awareness* (IRA) is used to measure metacognitive awareness specifically in the domain of reading comprehension, and was therefore inappropriate. Another well known test is the *Learning and Study Strategies Inventory* (LASSI) which asks students to self report on attitude, motivation and testing strategies, and correlates these with measures of cognitive performance (Weinstein, Zimmerman and Palmer, 1988). However, it is uncertain whether the instrument measures metacognition per se, or cognitive skills that are mediated by metacognitive strategies. A third measure is the *Metacognitive Assessment Inventory* (MAI) which measures knowledge and regulation of cognition, but it remains a paper and pencil inventory, with limited applicability to a broad range of contexts. Yet another approach to assessing metacognitive knowledge involves the use of think aloud protocols while students are concurrently engaged in completing a task. This has been criticised for placing undue cognitive load on students, as the think aloud process competes for limited resources that are needed for task performance.

In view of the controversy and lack of evidence for paper and pencil tests and for think aloud approaches, the authors decided on retrospective self-report data from participants. Self-reports include *retrospective verbal reports*, *concurrent verbal reports*, *written reports* and *self-estimates*. The approach adopted in the present study was to analyse transcripts of the focus group discussions (retrospective verbal reports) for metacognitive processes and indicators. As adult learners, the student-producers demonstrated a high level of awareness during the scripting and editing of the podcasts, and were expected to be responsive to the self-report approach as it was administered shortly after completion of the tasks. As further support for this approach to measuring metacognition, the weight of evidence seems to favour such an approach because: "… relative to other formats for assessing metacognition or self-regulation such as think aloud or interviews, self report questionnaires are easy for

teachers and students to use and can provide information about a large number of students in a practical and efficient manner" (Pintrich, Wolters and Baxter, 2002, p. 66).

Results. A total of 24 message units relating to metacognition were found in the focus group discussion transcripts, where students reflected on learning processes, skills developed, control and awareness of their learning strategies. Each major category had a number of subcategories, or related metacognitive skills (based on the research of White, 1999, Table 2). A summary of results is found in Table 2 below.

Metacognitive variable	Subcomponents	No. of message units	%
Self knowledge	Self-evaluation Awareness of effort needed Awareness of learning achieved	4	16.67
Task knowledge	Task demands Degree of task success Strategies applied to task	4	16.67
Strategic knowledge	Self management Resource management Peer group learning/support	8	33.33
Knowledge of plans and goals	Plans established Scheduling Persistence	8	33.3
	Total:	24	100.0

Table 2 Metacognitive features displayed in the discussions in focus group 1

Research question 2: Knowledge building processes

Analysis framework. As a result of the relatively high levels of metacognition found in the initial data set from the first focus group, the researchers found sufficient evidence in the self-reports to probe further and to investigate students' perceptions of knowledge creation processes. The analysis framework for the second data set adopted the categories developed by van Aalst and Chan (2001), who adapted four of Scardamalia's (2000) 12 knowledge building principles, for use as analytical tools to assess knowledge building in a design experiment involving teacher education students. The four categories are depicted in Table 3, along with exemplars of actual utterances of the student-producers who participated in the focus groups in this study.

Category	Description	Corresponding KB principle in Scardamalia (2000)	Exemplars from student-producers' discourse
Working at the cutting edge	Students pursue solutions to problems that transcend the mere fulfilment of personal interest, to advance the knowledge of the learning community	Epistemic agency	… even though I don't like structure, I'm aware that other people around me… either love it or hate it, or are in-between, so I am quite able to adapt to other people and make it work as a group.
Progressive problem solving	Students develop ideas and tackle problems at progressively deeper levels, with a knowledge advance possibly leading to new questions to be answered	Improvable ideas	During that process, we'd then decide, well, if we want this to come into the script, can we get this to sound better…? (On collaborative editing) … you still keep what you want but make it better…
Collaborative effort	Students assist one another in advancing their understanding, for example, by asking questions and providing constructive criticism of one another's contributions	Community knowledge, collective responsibility	… the other thing with that is, it helps out other students as well. That was probably one of the main goals that I got into it for… … it's about wanting to give back… [to the university community and the podcasting group]" … we all get together and 'nut out' a script…
Identifying high points in the discourse	Students are able to identify what they believe to be their best contributions to the knowledge building discourse. Here, the emphasis is on the student's own learning trajectory rather than on the development of an idea	Knowledge building discourse	You want to get your words right. Like your sentence structure, the way you put things together…

Table 3 Four knowledge building categories with exemplars from student-producers' reflective discourse (adapted from van Aalst and Chan, 2001)

In order for a student to be able to identify his/her significant contributions or "high points" and critically evaluate his/her individual learning from the knowledge building process, he/she must exercise self-reflective and metacognitive skills. Results of analysis of the first data set showed that participants were operating at a high level of meta-awareness, and it was predicted that knowledge building processes would be evidenced in the second data set.

Results. The transcripts of the data from focus group 2 was examined using the four categories, following a preliminary analysis of the participants' dialogue. The results are summarised in Table 4. A rating was given for the strength or evidence of each principle, using a five-point scale. A rating of 1 indicated that there was little evidence provided by the student of this principle, while a score of 5 indicated that there was strong evidence of occurrence supported by the discursive features described in Table 3.

	Working at the cutting edge	**Progressive problem solving**	**Collaborative effort**	**Identifying high points in the discourse**	**Percentage of KB features as % of total discourse***
	(Rating 1–5#)	(Rating 1–5#)	(Rating 1–5#)	(Rating 1–5#)	(Rating 1–5#)
Participant S1	2 (3) = 6	2 (2) = 4	2 (2) = 4	2 (2) = 4	8.0%
Participant S2	4 (4) = 16	4 (3) = 12	5 (2) = 10	4 (2) = 10	17.0%
Participant S3	4 (2) = 8	1 (4) = 4	3 (2) = 6	4 (2) = 10	12.0%
Participant S4	2 (3) = 6	2 (3) = 6	3 (3) = 9	4 (3) = 12	11.0%
Participant S5	4 (4) = 16	4 (2) = 8	5 (3) = 15	3 (2) = 6	16.0%
Total	20	15	21	19	64.0%
Mean	3.25	2.7	2.4	2.1	12.8%

\# Rating 1–5: for strength of each principle (1=weakest, 5=strongest)

* Knowledge Building (KB) features for each participant were calculated as percentage of total discourse*

Example: S1 showed 2 instances of "working at the cutting edge", and each was rated as 3 (medium level of evidence) on the scale, giving a score of 6 points. A total of 8% of knowledge building features were found in her contributions to the focus group.

S2 displayed the highest KB discourse, S1 the least.

Table 4 Indicators of knowledge building discourse features in focus group 2 as a percentage of total discourse

Although the authors acknowledge that data the set may be too small to make bold claims about knowledge building and the cognitive benefits of podcasts, the preliminary observations are very positive. While not many discourse elements were rated as level 5, there was certainly evidence of knowledge building among students. The category *collaborative effort* was the most salient and strongest knowledge building feature that emerged from the dialogue. This was not surprising, as the entire podcasting process was conducted in groups, and students participated and worked well as a team, sharing ideas and commenting on one another's scripts. A total of 64% of the discourse in the focus group was

found to have features indicating knowledge building, with each participant having a mean of 12.8% of their dialogue showing knowledge building features.

Discussion

In this paper the authors have described a project in which a team of students generated educational podcasts to assist other student cohorts, and in doing so engaged in an intensive process of teamwork, scriptwriting, editing and presentation, which immersed them in an extensive range of cognitive and metacognitive processes. Through collaboration and peer review of scripts created for this purpose, the student-producers engaged in knowledge creation processes. The results suggest that peer learning and the creation of audio learning objects for podcasting that enable student-producers to conceptualise content are powerful ways of both creating and consolidating new knowledge. The results suggest that the production of podcasts by students for an intended peer audience is likely to engage them in knowledge building discourse and increased metacognitive activity, which can result in improved learning outcomes. Currently, much use is made of podcasting technology as a distribution mechanism that may in fact undermine face-to-face teaching, or to augment online lectures by simply disseminating instructional content to learners. This replicates the traditional metaphor of learning as acquisition, which positions students as consumers of pre-packaged content and inert information. In adopting the epistemological stance of learning as knowledge creation, the authors facilitated a project in which students were given a high level of agency in the creation of audio learning objects, and in which the social processes of team work, dialogue and progressive problem solving were incorporated into the production activities surrounding the creation of the podcasts. While the products (podcasts in the form of DALOs) were indicators of success for students, their actual dialogic and social processes were the focus of the researchers' study. Without the tangible outcomes of shared activity (scripts and audio files) achieved through teamwork and joint articulation of goals, students may not have engaged in the processes of collaborative dialogue and metacognitive inquiry.

Two different but related frameworks were used to analyse data and inform the design of the study. The first framework was intended to assess the level of metacognitive activity in the recall protocols of students, using content analysis based on four key types of metacognitive knowledge. Results showed high levels of strategic knowledge (self and team management) and task knowledge (ability to plan and set goals). The second analytic framework employed Scardamalia's (2000) knowledge building principles, four of which were used to evaluate the extent to which participants showed evidence of knowledge building. The results indicate that students value collective cognitive responsibility and shared participation in the activity, and each student contributed to the improvement of ideas as they worked closely as a team. The two sets of results are interrelated and show that the strength of the group were in teamwork processes and collective problem solving and planning, with each participant as an active contributor. The results also showed the there was knowledge building at an individual and collective level.

Conclusion

The authors believe that group scaffolding in the form a shared activity or goal (in this case DALO creation) can facilitate both metacognition and certain collective knowledge building processes. Similarly, in the focus group discussion, the researchers' adoption of a structured set of questions for focus group discussion served to focus student dialogue so that they engaged in more intentional discourse, and reflective inquiry. There are several implications of the research for educators interested in using podcasting to support learning. First, the authors emphasise the centrality of student agency in the creation of podcasts as shared learning objects. In other words, the creation of the podcasts can serve as a catalyst of student engagement, if creation of the scripts and audio files is undertaken as a team effort.

Secondly, supporting and encouraging knowledge building discourse can be achieved by instructors in variety of ways, through task design supported by a variety of Web 2.0 or social software tools to promote high levels of self-regulation, collaborative inquiry and peer-to-peer dialogue. Finally, in contrast to other studies conducted on podcasting to support learning in higher education, the authors believe that the collective agency of students is the keystone of knowledge building.

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PAPER 1116

Widening access to educational resources: the development of tools to support deaf and hearing students

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Abstract

A tool to support hearing impaired students has been developed. This paper describes the evolution of the tool and discusses whether the tool may be adapted to integrate into the general learning environment of the wider student body to benefit the overall learning experience. Initial findings are presented and show that the concept has merit. Further developments to improve the effectiveness of the tool are described.

Introduction

In recent years there has been an increasing drive to provide wider access to the resources of higher education. This has to be achieved against the background of a more diverse student body with a range of different needs, abilities, aspirations and background. There is also a legislative context to this which requires providers of education to recognise diversity and provide equality of access and experience.

The authors have been involved in research to provide improved access to university education for deaf students. This has led to the development of two prototype products which are currently being deployed to support deaf students. The authors have now extended this work to provide a more general tool to make lectures and classroom interactions accessible to a wider range of students across a range of platforms. In particular the authors are investigating the question of whether a support tool that has primarily been developed to provide more accessible lectures and group work for hearing impaired students can be adapted and integrated into the general learning environment of the wider student body, and how best to achieve this.

In order to understand the evolution of the product and its further integration, the development of the support tool will first be described and set into the context of deaf students in higher education.

Background to the development of the prototype support tool for deaf students

The authors are lecturers working in the area of technology education and in particular, multimedia and computer systems. It was recognised that numbers of students were entering higher programmes with severe hearing impairments. The current figures in Scotland for deaf students entering higher education is approximately 2.6 per 1000 (Brennan et al, 2005). In the area that the authors are working, this figure is an underestimate; the programme that was used to evaluate the prototype had 4 deaf students out of a student body of 210 over the last 5 years.

One of the key skills that students should develop as part of the higher education process is "learning how to learn". Discussion and debate are critical parts of this process, and this helps move the student towards being an independent learner rather than one who simply accepts and applies the material presented by the lecturer. It is often difficult for a deaf student to become involved in this process, particularly where the subject being discussed has a high level of specialist terminology, such as in the area described.

Existing resources available to address the support requirements of the deaf students were applied but it became clear that they all had limitations. In particular it was apparent that while many of the technologies that were being discussed in the lectures were highly suited to the development of novel support solutions, using traditional support mechanisms such as signing and note taking was not very effective and did not make it straightforward for hearing impaired students to learn about the technologies. This was due to the complexity of the terminology used and the rapidly changing vocabulary. It was also found that when students with hearing impairments were involved with group activities, the traditional support mechanisms had major limitations in dealing with this kind of activity.

The following statistics give an outline of the current position and needs within Scotland for deaf people (Lawson, 2003) and hence some indication of the potential benefits of the application of assistive technology:

- It is estimated that 1,080,000 people have some degree of hearing loss (from a population of just over 5 million).
- 71% of deaf and hard of hearing people felt isolated by their deafness.
- Approx 6,000 Deaf sign language users.
- 42 registered Sign Language Interpreters (estimated that 300+ are needed).
- Unemployment among deaf people is four times greater than within the general population.

Pedagogical factors specific to deaf students

There are a range of issues which impact on the ability of a hearing impaired student to fully benefit from higher education. These are discussed in a document produced by the University of Wolverhampton (Mole and Peacock, 2002) and the elements relevant to this project can be summarised as follows.

- Most deaf students use a variety of communication methods (often simultaneously)
- Frequency loss with deafness means that in some situations a deaf person can hear adequately but not in others (particularly noisy or acoustically poor environments), for example lecture theatres.
- Only 30% of English speech sounds can be lipread.
- Both lipreading and signing are tiring activities which require regular breaks.
- Sign language interpreters and notetakers (scribes) are rarely trained in the subject they will be interpreting and thus do not have the dedicated sign vocabulary. Currently the only way that this can be addressed is for the lecturer, signer and student to work together to

create a set of new vocabulary terms for use in the signing process. This is very time consuming for any subject with high "jargon" content. If the shorthand for jargon has not been developed then the signer has to revert to the use of finger spelling and rapidly falls behind the lecture content. A development to help to address this issue is the development of "Sciencesigns" an online BSL glossary for Engineering and Science (Mole and Peacock, 2004), (Mole, 2006). It is a reference resource for signers, students and lecturing staff.

- Group discussions, even with one speaker at a time, are difficult as the deaf student needs time to identify the speaker. This often results in missing the first part of the contribution.
- Reading handouts while trying to watch the lecturer and/or signer is not really possible.
- Similar points were raised in a satellite telecast that was beamed to over 110 colleges and universities across the United States. "Focus On Faculty: Effective Pedagogy With Students Who are Deaf and Hard of Hearing" (Antle et al, 1998)

A further complication is the increasing "internationalisation" of the student body, since signing is non-uniform across borders. It is worth noting that due to the historical suppression of sign language, it has a strong regional nature and even within large cities, different signs may be used for the same word. This is anticipated to be a significant problem as remote learning (or e-learning, or Managed Learning Environments) become a key element in programmes of study. Research is being undertaken on "e-signing" to facilitate these methods (CDS, 2006), but again only "local" signing is being supported.

There are several different ways in which the educational system tries to support students with hearing impairments. Glasgow Caledonian University subscribes to the code of practice agreed by The National Deaf Children's Society (NDCS, 2001), and from this, the key resources that are brought to bear include:

- Copies of OHPs are issued prior to lectures to allow familiarity and context to be established.
- Where possible, lecturers notes or abridged lecture script are provided.
- Working arrangements are made with Sign Language interpreters including means of dealing with technical terminology (signs for difficult terms have to be devised in advance)
- To facilitate lipreading the lecturer must ensure that their face is clearly visible, in good light.
- Classes are chosen such that a radio microphone (linked to an induction loop system) can be worn.
- A scribe or "note taker" to accompany the student. (Often a student volunteer from the same course. but care must be taken or that person may find their own performance is adversely affected.)
- Tutorials are arranged in a semicircle to facilitate lipreading
- Procedures are arranged so that the student can follow and contribute to the group activity.

These techniques all work to provide support in a range of environments. Additional information is also available from the Royal National Institute for the Deaf (RNID, 2004). As well as the signing and note taking already identified, stenography can also be used but due to its expense and the rarity of trained staff, is rarely applied in practice.

Signing is the most common form of support used by students in the classroom environment. Signers are highly skilled and in great demand. This means that they are often booked several months ahead and therefore are difficult to fit into the timetable of the student.

The development of Talkshow

Given the limitations of traditional support methodologies, the increase in legislation, particularly the Disability Discrimination Act (DDA, 1995) and the Special Educational Needs and Disability Act (SENDA, 2001) in the UK and similar legislation in the EU and the US, as well as the desirability of increasing inclusion, the authors investigated a range of alternative ways to support deaf students. One area that was of particular interest was that of speech recognition. The associated technology had been evolving for years and by 2001 was at a stage where it was possible for suitably trained software to achieve a good standard of recognition of continuous speech on mid to high end desktop computer systems. An excellent review of the state of the art at that time and the issues involved can be found in a publication by the CALL Centre at Edinburgh University (Wilson, 2005). The potential of this technology prompted an investigation into the integration of voice recognition technology into a bespoke software application. The investigation identified a need for a low cost tool to improve the accessibility of higher education learning resources for these students while at the same time making it relatively easy for the teaching staff to utilise.

At the time of development of the first version of the product, there were a few products on the market that attempted to apply technological resources to improve the integration of hearing impaired students in the academic environment, notably from the Liberated Learning Consortium (Liberated Learning, 2001), but there has been little impact, in part as they were complex and expensive (Bain et al, 2002).

The prototype was targeted for students who were classed as profoundly deaf in that they relied on British Sign Language (BSL) or lipreading as their primary means of gaining information that would more usually be passed verbally. It was the experience of staff teaching these students that they would generally have good reading and writing skills. This cannot always be assumed as for most people who are profoundly deaf from birth, English is a second language, which is learned after BSL.

The prototype tool was designed to support students in the lecture and group environment. It was termed Talkshow (Stewart and McKee, 2001). It integrated an off the shelf voice recognition package with an application which runs in a subtitle mode under the presentation (See figure 1).

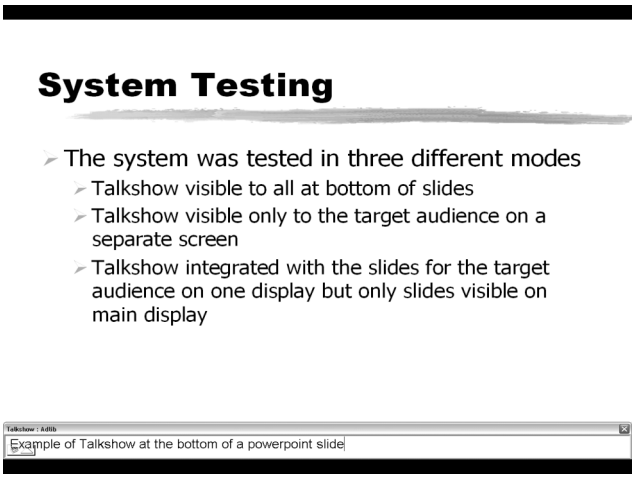

Figure 1 Screenshot of Talkshow running

Talkshow can be run in either autocue mode, with a prepared script or in adlib mode, where it is used to transcribe the lecturer's voice in near real time. It can also be used in adlib mode in the group context where the lecturer can echo the content of the individual students.

Following on from the Talkshow concept was the development of a support tool to further assist in group working or in one to one tutorial sessions. This application (termed the Communicator) utilised the same basic concept of applying an application to act as a front end to the voice recognition software. In this case, however, it was reconfigured so that the lecturer and the student shared the same screen, with the lecturer utilising voice recognition to drive the speech input side and the student utilising the keyboard to provide their input.

It can also be configured to run between two machines in a manner similar to instant messaging or chat. This is particularly beneficial as it allows the hearing impaired student to have ad-hoc sessions with the teaching staff, rather than have to set up an appointment and arrange for a signer to be present. There is a further benefit in that the content can be stored and checked by both parties to ensure that there is clarity and mutual agreement.

Results from the Talkshow project

By the end of 2005, the Talkshow prototype had been tested in both lecture and group working environments by several members of staff who were comfortable working with the technology. The key points that emerged from this period are identified below:

- The feedback from the deaf students was generally favourable.
- In general the speech recognition was sufficiently accurate to provide useful additional information to the deaf students.
- In most cases the content of the subtitles was found to be accurate and allowed the student to follow the lecturer's speech effectively.
- They were already used to having to read subtitles and multi channel information.
- When the speech recognition produced text that bore no relation to the speech, it was easily identified by the students and ignored.
- Technical terms and digressions which were used to illustrate the meaning of these terms were easier to pick up
- Questions from the class (if echoed by the lecturer) were also able to be followed, increasing the student's understanding of the topic and making the student feel more integrated into the lecture class.

The lecturing staff found that there was an additional benefit to using the tool. Technical terms which were commonly problematic for the signer to convey, were usually transcribed successfully by the speech recognition engine. Because the terms were unusual the recognition engine found them easier to match as there was less likelihood of a similar term in normal speech. This is a different result to that obtained by researchers at MIT (Park et al, 2005) This divergence was identified as being due to the time spent by the lecturer to train the system to recognise the terms.

In general the hearing students found the application to be an interesting novelty in the lecture, but the subtitling was a distraction due to the transcription delay, the visual distraction and the mistranslation.

Importantly for the subsequent direction of this work, a large proportion of the hearing students did, however, request that the transcript of the lecture generated by Talkshow be made available to them to support their revision work.

When Talkshow was utilised in small group work, it was found that it aided group cohesiveness significantly. This was done by using the Talkshow "trained" lecturer as a communications resource. When points were raised or questions were asked by the hearing students these would be repeated by the lecturer. With the additional use of other visual communication tools, (keyboard and other computer tools for sketching ideas as well as the use of pen and paper) it meant that the hearing-impaired student was much more able to follow the flow of the discussion, to pick up on ideas and to make a contribution. This led to a

greatly improved group atmosphere and a more productive working environment (Stewart and McKee, 2004)

The views of the lecturing staff varied as outlined below:

- The training time required for effective translation was considered to be too great in some cases.
- All staff who used the prototype felt that it was cumbersome. This has now been improved by the use of wireless headsets.
- Opinion was split over whether the technology had a positive or negative impact on the lecturer's delivery.

Overall the results showed that the prototype definitely improved the effectiveness of communication for hearing impaired students, particularly in lecture and tutorial environments. Current voice recognition software is still limiting the ease of use of the prototype as it requires a significant training period and practice with its use.

The Talkshow project is ongoing but at the end of this stage in its evolution, a new research question was raised. The wider student body had expressed a desire to have access to the lecture transcripts for revision purposes. This suggested that it would be valid to investigate whether the Talkshow project that had been developed to provide more accessible lectures and group work for hearing impaired students could be adapted and readily integrated into the general learning environment of the wider student body, to support their studies.

Developing the lecture capture framework

The initial stage of the research was to examine the current methods used to capture lecture content. At present it is common practice for students to record lectures. Most universities use Managed Learning Environments (MLEs) to provide flexible access to lecture content, typically presentation slides and notes (Mayes, 2006). There are also several attempts to capture the full content of the lecture (video and audio) and to make the content of the lecture much more straightforward to access.

Two examples of these projects are

- MIT's open courseware project (Opencourseware, 2006) which at present provides a large number of video or audio captures of lecture presentations together with associated notes or slides. However, the content can be difficult to navigate and search.
- A smaller project is Webducate (Webducate, 2006) which provides a simple and easy to use tool for lecturers to place the captured elements of their lecture into a format that is easy to read and to navigate. It is particularly designed to be an accessible resource.

Several commercial organisations are now moving into the area of lecture capture and annotation. Apreso Anystream (Apreso, 2006) for example provides a turnkey solution to the capture and integration into VLEs of lecture video and any content that is projected.

MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) (Park et al, 2005) is currently developing technologies in conjunction with Microsoft for the transcribing and indexing of academic lectures to facilitate audio information retrieval.

It is generally recognised that while it is desirable to provide access to as much learning material as possible, and in a range of formats, for the student to study, some form of indexing of the content will greatly improve its effectiveness as a study tool. If the capture and transcription of the spoken presentation is sufficiently accurate, this would provide a viable route to searching and indexing the content of the lecture. This would be particularly supportive in addressing a range of learning styles and would enhance consolidation.

Research has shown that in a typical lecture environment, using a standard, unidirectional microphone, attached to a video camera, to capture the content of the lecture, errors in

transcription of the text in the order of 30% to 40% are to be expected (Glass et al, 2004). This result differs significantly from that found when using a dedicated noise cancelling headset microphone where more typical error rates of 10% to 15% are encountered (compared with approximately 5% in a quiet office environment) (Wald, 2006). These differences in error rates are due to a number of factors as well as the microphone type. Like the authors, Wald is using a trained voice recognition application (in this case ViaScribe (IBM, 2006)) which has been trained to recognise the specialised vocabulary used by the lecturer. ViaScribe is a powerful but expensive development by IBM and the Liberated Learning Consortium of the standard off the shelf voice recognition product ViaVoice. It addresses a range of issues with standard automatic speech recognition products, particularly the automatic formatting of the output text and the ability to provide access to the synchronised text and speech data in non proprietary formats (Wald, 2006).

It is now possible to provide a rich set of resources to represent a lecture (or other classroom activity). These resources include video, raw audio, automatically transcribed text of the presentation, the slides or other screen based interactions, input from smartboards, links to further reading etc. The challenge is how to provide them in an accessible and easy to use format that will make it easy to navigate and select the relevant information (for example linking a solution to a tutorial question to a small part of a lecture presentation). In addition the students may want to access the content in a variety of formats, for example, simply the audio (or possibly the video) for downloading to personal media players, or the text of the lecture and the presentation itself linked on a timeline for printing out for review of the content.

The initial investigation showed that there was a potential need for a low cost resource to provide automatic transcription and navigation of lecture content.

Based on this investigation, in 2006 Talkshow was utilized within a module with significant technical content in the final (honours) year of a bachelor's degree programme. At this stage of the development the project was viewed as a software prototyping project and the initial activity was designed to elicit feedback from the students to inform the subsequent iterative development of the specification for the tool, based on the potential identified needs outlined above.

Talkshow was run during the lecture but not made visible to the students. The captured text was subsequently edited to remove obvious transcription errors and irrelevant content. It was then made available to students on the MLE along with the captured audio from the lecture and the PowerPoint slides.

Informal discussions with the students were undertaken during tutorial sessions for the module and the following points emerged from the discussions.

The students identified several benefits to the transcribed audio.

- They found that, unlike captured audio or video, it was easy to scan through the content to identify the area that they wanted to review. In some cases the students used search tools to make this process more efficient.
- The compact nature of the file meant that it could be stored and displayed on devices with relatively little memory such as smart phones.
- The ability to print out the content and annotate the captured text was found to be extremely useful as a study tool.

There were also several disadvantages of the transcribed audio compared to other forms of lecture capture

- The most common complaint was that even with some editing, the content was not always easy to follow due to transcription errors that had not been caught by the lecturer.
- Parts of the presentation, such as emphasis and inflection were not present in the text version which reduced the clarity of the content.

- As it contained a direct transcription of the lecture content, when the content was not well structured, for example with several digressions, it was difficult for the students to follow the lecture.
- In common with audio capture, it was not always clear when slides were changed in the presentation, making it more difficult for the students to follow the flow of the presentation.

The overall consensus from the students was that the transcribed audio was a useful additional study resource but they felt that it was not well integrated with the other resources. They also recognised that the content was easy to edit and adapt and so they felt that a greater level of interaction with the material could be possible.

From the staff perspective, the main limitation encountered was the time taken to revise the text. This normally took between 1 to 2 hours to adapt and correct the unstructured content.

Based on this feedback and subsequent discussions with the students it was clear that the transcribed text provided a searchable framework which could be developed to act as a backbone for the other lecture media. The transcribed content needs to be linked to keyboard interactions or other cues during presentations. These events would provide the timeline which will allow the lecture content to be navigated and the content indexed. The project should also allow the content to be adapted and modified by both the staff and the students to create a richer set of educational resources which engage the students more in the content being presented.

From these discussions, a more formal specification for the next stage of the project has been developed. The key points are:

- The various items of captured lecture content should be presented in a common framework, with a common timeline to allow navigation through the material.
- The transcribed text should be able to be linked to other resources so that the lecture content can be enhanced and extended after the presentation. Example of this include:
  - Clarification of topics and expanded definitions of terminology.
  - Links to supporting media provided at the appropriate point in the transcript.
  - Links to tutorials.
  - Questions raised by the students as they review the content and the responses from the lecturer or fellow students.
  - Annotations and comments from individual users.

By developing the tool in this direction the captured content moves away from being a simple record of the content of a presentation and into a more dynamic educational resource which better supports the student's learning.

Conclusion

The support tool that was designed to assist deaf students to access the resources of higher education more effectively has been adapted to provide a tool that supports the learning of the general student body. Initial feedback from the students on the pilot test shows that even in a basic format, the availability of the transcribed text of lectures provides benefits. The application of this methodology and technology to learning support for the general student body is worthy of further development and refinement. The evaluation of the pilot has informed the further developmental needs and in particular has confirmed that a cost effective and inclusive learning support tool based on the technologies discussed in this paper can become a reality.

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PAPER 1113

Lecture recordings: extending access for students with disabilities

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Abstract

The introduction of a lecture recording system at many universities has received considerable endorsement from advocates of accessibility, with students with disabilities and/or medical conditions being identified as major beneficiaries of this resource. To gain a better understanding of the perceived benefits and shortcomings of recording lectures for this group of students, and potential directions and applications for the future, a research project was recently conducted at one university into this topic. This research acts as the basis for this paper; the presentation will briefly overview the project and share key research findings.

Introduction

The lecture method remains a common university teaching practice despite mounting criticism regarding its educational legitimacy. In order to make this teacher-centred teaching method more flexible and accessible to a increasingly diverse student population, many universities are considering the implementation of a lecture recording system.

Recording audio and video material from university lectures for students to access outside the lecture theatre has been repeatedly acknowledged over the years as beneficial for many students (Bligh, 1972; Laurillard, 1993; Biggs, 2003). Inaccessible for some, recordings of lectures allow all students the ability to review lecture material at their own pace in environments in which they are comfortable, as many times as required and in the format that suits their needs. Students who have a different native language to their lecturer, those with work commitments and timetable clashes, and students who have learning styles not suited to the face-to-face lecture method have been found to particularly benefit from the ability to access lecture recordings (Williams and Fardon, 2005).

Another group of students who are thought to derive learning support from the availability of lecture recordings are those with disabilities and medical conditions.

In 2002, the Australian Senate published a report observing that advances in technology have resulted in assisting students with disabilities to gain greater access to higher education, noting that “Advancing technology is easing the burden for students with disabilities in accessing higher education. The past decade has seen unprecedented technological change affecting disability assistance. The advantages of technology for students with disabilities include improved mobility and communication and access to information. New technologies can greatly enhance a student’s level of independence, and allow a student to achieve academic success with little or no disadvantage” (Employment,

Workplace Relations and Education References Committee, 2002). A lecture recording system that translates the often inaccessible face-to-face lecture method into a more flexible digital format is a powerful example of this type of 'enabling' technology.

Throughout the literature that addresses issues relating to students with disabilities and medical conditions in higher education, the practice of recording lectures is frequently attributed with providing flexibility and advancing learning (Exley and Dennick, 2004; Leung et al., 1999; Skill: National Bureau for Students with Disabilities, 2004, 2005). In a report to the Australian Commonwealth Department of Education, Science and Training, it was noted that "Students with disabilities prefer courses that are presented in flexible ways, particularly where this means that the content is presented via several different means. For example, students prefer courses that are presented through a combination of face-to-face lectures, lecture notes, and online recordings" (University of Western Australia, Disability Services, 2002). Many universities around the globe endorse this approach, and place recommendations on their websites that lecturers consider recording lectures for the students with disabilities who may attend their lectures (for example: Australian National University, 2005; Monash University, 2003; University of Adelaide, 2005; University of Cardiff, 2005; University of Edinburgh, 2006).

The majority of these websites feature relatively simple, straightforward statements along the lines of: "People with mobility, visual or hearing impairment, and people with dyslexia, can benefit from being allowed to record lectures and discussions" (University of Cambridge, 2004). Others, such as the University of Newcastle's Disability Support Services website, enter into more detail. Newcastle's website provides information sheets for staff on 21 different disabilities from Attention-Deficit Hyperactivity Disorder (ADHD) to Vision Impairment, and every one of these information sheets contain the recommendation that lectures should be recorded (University of Newcastle, 2005). Common amongst all of these university websites, however, is the perspective that recording lectures alleviates the pressure on students with disabilities to take notes during a lecture, provides an avenue for the efficient review and revision of core course material, and is an important resource should regular attendance at the live lecture not be possible due to their medical condition.

Project overview

Objective

At the University of Western Australia (UWA), as with many other universities, the practice of recording lectures to provide flexible access to lecture materials for students with disabilities and medical conditions is firmly established. The lecture recording service, utilising a home-grown system called Lectopia, has been identified by UWA as critical for this group of students, alongside other services and facilities such as the provision of specific equipment and furniture, extended library services and advocacy support (University of Western Australia, 2006). As with the majority of students studying at UWA, students with disabilities remain expected to attend live lectures and use the recordings as a supplementary learning resource rather than a replacement, where possible.

The number of students with disabilities or medical conditions enrolling in courses at UWA is not insignificant. For example, at UWA in 2005, 902 undergraduate students acknowledged on their (re-)enrolment form that they had a disability which represents approximately 7–8% of the total undergraduate enrolment at the University. The UWA enrolment form has six disability condition types for students to select: 'learning', 'hearing', 'vision', 'mobility', 'medical' and 'other'. Note that 'learning' includes dyslexia and ADHD. In 2005, the highest proportion of students indicated their disability was 'medical' on their enrolment form (31%), whilst 10% stated a 'learning' disability and 7% 'mobility'. It is important to note that indicating

a disability condition type on the enrolment form is not a requirement: 31% of students who acknowledged a disability did not select a disability type.

Given the high numbers of students with disabilities and medical conditions studying at UWA, it is vital that the University ensures that their learning needs are being appropriately supported. As noted above, the recording of audio and video from university lectures for students to access online is an accepted practice at UWA, and is held to be an important learning resource for students with disabilities. However, to date our only evidence that these students benefit from the provision of lecture recordings has been taken from informal or anecdotal feedback, and student surveys which have occasionally elicited general information about the use of Lectopia from students with disabilities. Although national and international studies have previously been conducted into the use of audio-cassette lecture recordings by students with disabilities, little recent research has been undertaken to understand the ways in which online lecture recordings with audio and video material are being used, and what impact they are having.

To address this absence of formal research in this area, a project was devised and conducted at UWA in 2006 to capture more substantial information and gain a wider understanding of the pedagogical and practical implications of the use of lecture recordings by students with disabilities. It was anticipated that the project's findings will be useful across the international higher education industry, whilst at a local level they will inform UWA's policies for supporting the learning needs of students with disabilities.

Summary

The research for this project was conducted at UWA throughout the duration of second semester 2006, and involved a range of research methodologies as described below.

Over a three week period in July 2006 (10 to 28 July), a survey was distributed to all UWA undergraduate and Masters by Coursework students who had acknowledged a disability or medical condition on their enrolment form. It was estimated that a possible 15–20% of the survey recipients would have had no experience of the Lectopia lecture recording system, either because their lecturers chose not to use the system or because the lecture method was not used in the course teaching.

The anonymous survey was sent in printed form to 578 undergraduate students and 57 Masters by Coursework students. In addition, 7 undergraduate students received access to the survey online, due to their severe vision impairment disabilities. In total, 642 UWA students were sent a copy of the survey.

23 students returned the survey uncompleted because they were undertaking courses that did not use the lecture method; 3 surveys were returned unopened. A total of 130 completed surveys were received, resulting in a 21.1% response rate.

The survey, co-authored by the UWA Disability Office, addressed a series of issues relating to the use of lecture recordings by students with disabilities or medical conditions and included questions on topics such as accessibility and attendance:

- Type of disability or medical condition.
- Tools used to access lecture recordings.
- Preferred delivery format for lecture recordings.
- Frequency of attendance at live lectures.
- Frequency of use of lecture recordings.
- Reasons for using lecture recordings.
- Comments on the practice and pedagogical value of recording lectures.

Following on from this survey, a focus group was held in October 2006 to discuss the issues raised by the survey in more detail, and seek feedback about the topic of lecture recordings in a more informal setting.

This targeted research, focusing on lecture recordings and their use by students with disabilities and medical conditions, was undertaken alongside a series of campus-wide research activities. Over a three-week period (28 August to 15 September 2006), a campus-wide online student survey was conducted into the use of lecture recordings at UWA, seeking extensive information about how and why the resource was used across campus by students of all ages, demographic groups and course types. Many of the questions asked in this survey were identical to those asked in the survey of students with disabilities, and therefore provided a useful point of cross-referencing. This campus-wide research project also involved a set of focus groups which work to provide further context for understanding the use and application of the lecture recording resource at UWA for all students, including those with disabilities and medical conditions.

In addition to the surveys and focus groups outlined above, research for this project encompassed other sources of information about the use of lecture recordings at UWA, including system statistics and student usage reports extracted from the recording system.

Project results

The results from the 2006 survey of students with disabilities and medical conditions revealed overwhelming support of Lectopia at UWA with almost all students rating it as an 'Essential' or 'Useful' learning resource (65.7% and 32.4% respectively). In the comments section of the survey, remarks illustrating this support were commonly articulated, for example: "It has made attending university possible. (Thank you)".

As shown in Figure 1, the survey showed that, depending on their disability, students rated the lecture recording service differently. The most commonly acknowledged disabilities, 'Learning' (34.5%) and 'Medical' (30.1%), particularly valued lecture recordings as essential to their learning; those with 'Hearing' and 'Mobility' disabilities rated the resource less highly.

	Total	Hearing	Learning	Medical	Mobility	Vision
% of survey respondents	100%	6.2%	34.5%	30.1%	14.2%	15%
Essential	65.7%	50%	71.4%	66.7%	50%	62.5%
Useful	32.4%	50%	28.6%	30%	50%	31.2%

Figure 1 Learning value of lecture recordings against type of disability or medical condition.

Prior to the survey taking place, the team managing the lecture recording service at UWA had been led to understand that a high percentage of students with disabilities required specific software products to gain access to the recordings. The system development team had worked closely with students who regularly used software such as Jaws, Dragon and Zoom Text to ensure that Lectopia met the accessibility needs for as many students as possible. Interestingly, the survey results showed that only a few students required specific software to access recordings (less than 5%). Those who did, however, were appreciative that their access to lecture recordings was not impeded by their specific IT requirements.

At UWA, lecture recordings are made available to students in an average of fifteen different formats (including QuickTime and Windows Media formats, at a range of file sizes) to ensure

that students are able to easily access the recordings, regardless of their network connection or playback preferences. The most popular recording delivery format in the survey of students with disabilities was 'Download', with over half the number of respondents indicating that this was their preferred format (52.9%), with 26.5% choosing 'Streaming' and 20.6% noting that they had 'No preference'. These results were echoed in the campus-wide survey that was conducted later in 2006, where 53% of students recorded a preference for 'Download'. The results from both of these surveys indicate that, although a reasonable proportion of students were satisfied with streaming or had no preference, the majority welcomed the flexibility that the download formats provided—specifically the ability to access recordings offline, to have more control over recording playback and review, and to put them onto mobile devices.

Although a question regarding preferences for audio-only recordings against audio-video recordings was not specifically included on the disability survey, numerous comments revealed a strong preference for recordings to capture the presenter's computer screen or material from a document camera as well as the audio. For example, "Visually recording all lectures that have visual aids" and "Visual essential of lecture slides not just audio recordings". In the focus groups that were held in October 2006, one student stated that the audio becomes invaluable when it is synchronised with the visual material presented in the lecture. Whilst Lectopia does have the capability to automatically capture video material from lectures, not all lecturers choose to use this feature—despite almost 75% of students in the 2006 UWA campus-wide survey reporting that they prefer recordings with video material of either the presenter's screen, the document camera or the lecturer him/herself.

The results from the two student surveys demonstrated that students with disabilities and medical conditions used the lecture recordings more frequently and accessed individual recordings more times than the student population as a whole, as shown in Figures 2 and 3. Students with disabilities were more likely to access recordings 'Always' or 'Regularly' during semester; they were also more inclined to access the recording more than once, and over 5% of survey respondents stated that they would often access an individual recording on five or more separate occasions. Although the differences in these figures are not dramatic, they do point to the greater reliance that students with disabilities have on this technology in their learning activities that the student population as a whole.

	Always	Regularly	Occasionally
Campus-wide survey	22.9%	47.6%	29.5%
Survey of students with disabilities	29.7%	56.8%	13.5%

Figure 2 Frequency of use of lecture recordings during semester across both student surveys.

	Once only	2–4 times	More than 5 times
Campus-wide survey	67.6%	28.9%	1.5%
Survey of students with disabilities	59.5%	35.1%	5.4%

Figure 3 Frequency of use of an individual lecture recording across both student surveys.

In both the campus-wide survey and the survey of students with disabilities, students were asked to list their reasons for using lecture recordings. An analysis of these reasons enables a better understanding of why students with disabilities may rely more on lecture recordings in their learning than many others.

Reasons for using lecture recordings: campus-wide survey

Using lecture recordings for revision purposes and reviewing concepts was revealed to be the most common use of this resource in both student surveys, as shown in Figure 4. Note that students were permitted in both surveys to nominate one or more reasons for why they used lecture recordings.

Whilst students with disabilities demonstrated a higher dependency on Lectopia for revision and concept review than those responding to the campus-wide survey (80.5% compared with 70.1%), accessing recordings to manage timetable clashes and work commitments was significantly more popular in the campus-wide survey (47.3% and 38.8% compared with 10.2% and 5.1%).

	Revision and concept review	Timetable clash	Work commitments	Regional location
Campus-wide survey	70.1%	47.3%	38.8%	2.3%
Survey of students with disabilities	80.5%	10.2%	5.1%	0.9%

Figure 4 Common reasons for using lecture recordings across both student surveys.

Perhaps because of their acknowledged lesser dependency on lecture recordings to support timetable clashes and work commitments, the survey of students with disabilities recorded higher figures in terms of attendance at live lectures than the campus-wide survey, as shown in Figure 5. In the campus-wide survey, 24.4% students said that they ‘Always’ attended lectures compared with 42.6% of students from the disability and medical condition survey. In total, 88.3% students with disabilities noted that they attended lectures either ‘Always’ or ‘Regularly’, almost 10% more than the figures extracted from the campus-wide survey.

	Always	Regularly	Occasionally	Never
Campus-wide survey	24.4%	55.2%	15.7%	4.7%
Survey of students with disabilities	42.6%	45.4%	11.5%	0.8%

Figure 5 Attendance at live lectures across both student surveys.

Reasons for using lecture recordings: survey of students with disabilities

As observed above, the majority of students with disabilities who responded to the 2006 UWA survey used lecture recordings predominantly as a revision tool, to prepare for essays and examinations and to review difficult or complex concepts that have been presented in the lecture. However, this targeted survey did reveal some uses that seem to be specific to students with disabilities, uses that were not present in the campus-wide survey. These reasons fell predominantly into two categories:

- Unable to take notes during the live lecture. 39.8% of students who responded to the disability survey stated that they used lecture recordings because they were physically unable to take notes during the lecture itself. Comments such as this appeared regularly in the survey results: “I have stress fractures in my wrists, so writing quickly and solidly for 45 minutes is quite painful. Having recorded lectures allows me to review the lecture later at a slower pace to relieve the stress on my wrists”.

  Of the 39.8% of students who acknowledged difficulties with note-taking, over half of them had learning-related disabilities (56.4%). Dealing with the pressure of keeping up with the content in live lectures was often critical for students with dyslexia and ADHD, and their need for the recording resource was often acute. Put simply by one student: “I find it very difficult to take notes in lectures, so recorded lectures are very valuable to me”.

  Interestingly this form of use by students with disabilities, using lecture recordings to manage note-taking pressures, tied in with comments made by students in the campus-wide survey relating to their own flexible learning practices. For example, some students expressed a preference for simply listening at the live lecture and taking notes later: “I do not need to take notes in the lecture—rather I jut [*sic*] listen and revise by taking summary notes from the lecture recordings” and in one of the focus group sessions, a student stated that “With Lectopia, you can go to a lecture and not have to write anything, just listen and take notes later from the recording. It means that you take more in … it is invaluable from that perspective”.

- Unable to attend live lectures due to disability. 24.6% of students who responded to the disability survey stated that their disability would sometimes affect their ability to attend live lectures. In these cases, the availability of lecture recordings was invaluable: “Having a fatigue disorder it is important that my day to day life be flexible to what energy I have. Listening to Lectopia, I can study when I’m able to”.

  Of the students who found that their disability sometimes prevented them from attending lectures, many requested that more courses utilise the lecture recording service: for example, “We need more lectures recorded”, “Many units do not take advantage of this please make more people record” and “Please make more units available for online lectures”.

  It is worth noting that, of the 24.6% of students who are unable to attend lectures on occasion because of their disability, 68% recorded on their survey form that they had

medical and/or mobility disabilities. Whilst the lecture recording service at UWA is not intended to be used as a replacement for attendance at face-to-face lectures, from the survey it was very much apparent that many students relied heavily on this resource at times when they were unable to attend—whether it be because they were receiving medical attention or were physically unable to come to campus, or because they had work commitments or timetable clashes. Offering a lecture recording service to students acted for many as a safety-net, a 'just in case' solution should attendance not be possible.

Considerations and conclusions

Compulsory recording

In the written comments section of the disability survey, over 60% of respondents requested that UWA make recording lectures compulsory for all courses that use the lecture method: for example, "All units should have recordings available" and "ALL lectures should be recorded if this is going to be a useful system".

Taking this a step further, some of the survey feedback revealed a high-level of frustration with a handful of lecturers who did not appreciate the learning benefits that many students with disabilities derived from lecture recordings and did not deal with recording requests sensitively: for example, "One lecturer said that don't bother asking to have lectures taped unless you have two broken legs and a broken neck. Another said technology was 'too hard' hence not taping. In the year 2006 these are both very poor and unacceptable attitudes". The experiences of this student were supported by an opinion voiced in one of the focus groups where a student said that "My main problem with Lectopia at UWA is that any lecturer can choose for any reason not to use it. UWA need to make recording lecture compulsory, particularly if there are students with disabilities in class—a ruling needs to be made".

This incredible demand from students with disabilities for all lectures to be recorded needs to be closely considered at a university-level.

Currently at UWA, as at most other universities around the whole that have installed an enterprise-level lecture recording system, the lecture recording service operates on an 'opt-in' approach where individual lecturers make the decision to record their lectures or not. However, in an attempt to support demand for lecture recordings (not only from students with disabilities but from a large proportion of the total student population), a small number of universities are now considering an 'opt-out' approach where lecturers who do not want to record will be required to explain their reasons why, and all other lectures will be automatically recorded and published. For at least two of these universities, a central aim behind this potential shift in service provision is to better support the learning requirements of students with disabilities. It should be noted that the 'opt-out' approach is not currently being considered at UWA.

Many students clearly believe that changing university policy to extend the practice of recording lectures in this manner will be beneficial to their learning activities. According to the results from the 2006 UWA surveys, this belief is equally strong for students with disabilities as it is for the wider student population. However, any university planning to move towards an 'opt-out' approach will have to closely monitor and evaluate this shift to ensure that any negative impacts (such as a reduction in the morale of lecturers or significant reduction in attendance figures) are quickly addressed.

New directions

With any educational technology, there is a need to constantly evaluate and assess its use to ensure that it continues to support and enhance learning for students, and the practice of

recording lectures is no different. In conducting this project into how and why students with disabilities are using Lectopia at UWA, useful feedback was obtained that will work to further inform the University's approach to enterprise-level lecture recording with regards to both current practices and future directions.

For current practices, something that was apparent from the survey results was that improvements could be made in terms of increasing staff understanding of the Lectopia resource and its capabilities at UWA. Comments such as these were common in the survey responses: "Teach lecturers about using the overheads that get recorded into the lecture not sure what this is called, but its excellent. Some lecturers don't use as they don't know how" and "Perhaps a brochure or small operations checklist to help teaching staff create the best quality recording". Whilst the UWA Lectopia team make every effort to disseminate information to advise lecturers about the service and available features, it is clear that more needs to be done. Particularly important is that lecturers are kept abreast of what is possible (for example, streaming/download/podcasting and audio-only/screen capture/document camera) so that they are able to make informed decisions about how they would like the recordings to be made available to their students.

In terms of potential future directions, a number of students in the surveys and focus groups requested that the use of Lectopia be extended to encompass seminar and workshop environments: for example, "make tutorial recordings available for students unable to attend same (medical reasons)" and "most of my classes are seminars, however it would be useful if some of these were televised as I cannot always attend live sessions". Whilst these requests are understandable, there are numerous issues that would need to be addressed before this activity could be made possible, such as the necessity to install appropriate audio-visual equipment and network access into seminar spaces. Further, if seminar discussions were recorded and made available, issues relating to student privacy and intellectual property would require consideration.

Summary

This project sought to gain a better understanding of the use of lecture recordings from both a practical and pedagogical perspective by students with disabilities and/or medical conditions at UWA. The results of the project have confirmed that lectures recordings are seen by most UWA students with disabilities as essential, contributing towards creating an inclusive, equitable learning environment at the university. With the majority of students still attending lectures and using the recordings for revision and reviewing concepts, the technology is very much viewed as an 'enabling' resource that supports student learning and enhances accessibility.

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PAPER 1140

Assessing the usefulness of mini-games as educational resources

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Abstract

Interest in educational gaming is on the rise once again, and particular interest has started to peak in the area of lightweight educational mini-games. These games are often distributed virally by users of Internet forums and social networking sites, thanks to their self-contained nature and ability to offer a few minutes of intense fun. But are these games really as useful as people suggest, or are they simply too shallow to convey sufficient pedagogical meaning? And how do we assess how well these games measure up as educational resources? This paper first generates a "conclusive" list of educational requirements from a structured review of other researchers' proposed requirements. It then presents details of the three most interesting educational mini-games taken from an investigation of around thirty. Whilst some games were able to offer immersive, curiosity-provoking experiences full of relevant information, many of the games were shallow, formulaic, and lacking in information. Finally, conclusions and future work are proposed, including the packaging of mini-games into compendia to add depth, the use of mini-games in blended learning scenarios, and mechanisms to harvest the relatively simple player interactions to assist learner assessment. These findings aim to help educators make a more informed decision as to whether these games are right for their educational aims.

Introduction

The interest surrounding gaming in education has waxed and waned several times over recent years (Angelides and Paul, 1993; Squire, 2003; Gee, 2004; Pursel and Bailey, 2005). One recent peak of interest focuses on the area of mini-games—short, self-contained games, usually based around a single principle, be it ludic or pedagogical. Favoured by the social networking generation, these self-contained games are readily traded through Internet forums and social networking sites, as users seek to offer their contacts a few moments of brief but intense gaming distraction. But are these mini-games really that useful in an educational context? Are they deep enough to illustrate the full pedagogical content of a given area? And what set of requirements do we use to evaluate their quality as educational resources?

This paper aims to assess the educational usefulness of mini-games in several steps. First, a structured review of requirements proposed by other researchers is presented, in order to generate a more conclusive overall list of requirements for a good educational resource. Next, an investigation is carried out into a selection of "educational" mini-games, with their

qualities compared to the requirements in the list. Finally, the overall usefulness of these games is analysed, with suggestions made for improvements, in order to make them more useful in educational settings. These conclusions should allow instructors to make more informed decisions about the inclusion of mini-games in their teaching.

Structured review of requirements

Research claims that a number of requirements for e-Learning can be met by the affordances of computer and video gaming. But where did these requirements come from? Different researchers propose different requirements for an e-Learning resource, so which ones should actually be used? This section highlights some of the work regarding the requirements of an e-Learning resource and cross-references them. In doing so, we draw up a more conclusive list of requirements that an educational game must fulfill, and we can begin to assess the usefulness of games in education.

Laurillard's "Conversational Framework" (Laurillard, 2002) proposes several interactions that must take place for successful learning to occur. An instructor should create a theoretical model of a topic, and should help learners to create their own versions of this model through mutual, iterative articulation. Another key idea of the framework is that of an "experiential environment" allowing the learner to exercise goal-based behaviour. The learner reflects on their own conceptual understanding and adapts their behaviour in the experiential environment accordingly. Through a mixture of feedback both from the environment and the instructor, they will become more aware of how their own conceptualisation can be applied to a practical scenario. Similarly, the instructor can reflect on his or her own theoretical model and adapt the experiential environment in order to make it more useful to the learner.

The key points to take away from the framework are that:

- *instructor-learner interaction should be reciprocal*—this allows instructors to keep track of and feed back on learners' progress, and to update their own models and environments to improve the learning experience.
- *any theoretical or conceptual model must be exercised in a practical environment*—this gives contextual meaning to the model, allowing it to be successfully applied to future practical situations.

Laurillard also highlights a second conversation—one between the learner's "externally situated" and "internally persistent" selves (Laurillard, 1999). It is important for the learner to integrate their conceptualisation of a more specific model with a more generalised, persistent one. In doing this, the learner improves their generalised model to include the more specific, newly acquired context-specific information. Without this internal conversation, new knowledge will only be applicable within a single context, with no potential to apply it to a more general set of scenarios.

Koper and Olivier come up with their own set of requirements, suggesting that learning is becoming more "learner-centred, nonlinear and self-directed" (Koper and Olivier, 2004). This, in turn, suggests that traditional instruction is becoming less dominant in education, with emphasis now being placed on the learners developing knowledge on their own terms. This mirrors Laurillard's "Conversational Framework", focusing on learners exercising their conceptualisations in a practical environment and developing their internal models as a result. This learner-centric approach encourages learners to develop their internal models more strongly than in more traditional instructor-centric learning.

Some of the requirements proposed by Koper and Olivier include:

- *integrate learner and instructor activities*—this improves the articulation between the conceptual models held by the learner and the instructor.
- *be customisable to different users' needs*—to be as useful as possible, a learning resource should be customisable based on users' existing knowledge and educational requirements. This allows more relevant information to be presented to the user, without boring them with existing knowledge or frustrating them with information that is too complex. This customisation should ideally be automated in real-time, making the learning experience as appropriate as possible at any given time.
- *be compatible with different standards*—a learning resource should be compatible with compliant environments, allowing it to be reused by multiple users without any further development.

Koper and Olivier also draw attention to Merrill's "first principles of instruction" (Merrill, 2002), which suggest learning is promoted when:

- *learners are engaged in solving real world problems*—exercising within a real-world scenario instantly gives contextual relevance to anything a student learns. Without such practical engagement, new knowledge remains theoretical, making it difficult to implement it in a practical environment.
- *existing knowledge is activated as the foundation for new knowledge*—analogous to the conversational framework, if a learner's existing persistent knowledge is used as the basis for new specific knowledge, the new knowledge is given long-term, contextual meaning.
- *new knowledge is demonstrated to the learner*—as shown in the "articulation/re-articulation" section of the Conversational Framework.
- *new knowledge is applied by the learner*—seen in the "action/feedback" section of the framework, where the learner acts within the experiential world established by the instructor.
- *new knowledge is integrated into the learner's world*—this applies to the entire right-hand side of the Conversational Framework, where the learner assimilates new specific knowledge into their own existing persistent representations.

Paras and Bizzocchi (Paras and Bizzocchi, 2005) highlight yet more requirements, in the form of Norman's "seven basic requirements of a learning environment":

- *provide a high intensity of interaction and feedback*—this is needed for the learner to successfully alter their actions based on progress within the environment. Without feedback, the user might not notice any mistakes they are making; without sufficient interactivity, the environment will be unable to generate enough useful feedback with which to guide the user.
- *have specific goals and established procedures*—goals are useful, as they provide learners with something to aim for. Without established procedures, the student may become frustrated in trying to determine the methods used by the system.
- *motivate*—if the learner is motivated, they are more likely to drive themselves through the learning process without the need for external encouragement.
- *provide a continual feeling of challenge that is neither so difficult as to create a sense of hopelessness and frustration, nor so easy as to produce boredom*—similar to Koper and Olivier's customisation requirement, this ensures the learning process targets the learner's exact needs and abilities, keeping them motivated by balancing between boredom and frustration.
- *provide a sense of direct engagement, producing the feeling of directly experiencing the environment, directly working on the task*
- *provide appropriate tools that fit the user and task so well that they aid and do not distract*

- *avoid distractions and disruptions that intervene and destroy the subjective experience*—these three requirements all relate to promoting an immersive learning environment. By immersing him or herself fully, the learner can absorb information from their own experiences, rather than from instruction. If the immersion is interrupted, the learner's experience will be less effective (Csikszentmihalyi, 1997), making it important to use tools and techniques that maintain the immersion.

Paras and Bizzocchi further illustrate the importance of motivation by referring to M. Keller's "ARCS" method (Keller, 1987):

- *"Attention strategies" for arousing and sustaining curiosity and interest*—if the environment generates curiosity, learners will be more motivated to explore by themselves.
- *"Relevance strategies" that link to learners' needs, interests, and motives*—when clearly-defined goals are linked to the learner's own learning interests, the learner becomes more motivated to pursue the goals, learning more about the subject as a result.
- *"Confidence strategies" that help students develop a positive expectation for successful achievement*—once again, the need to balance the learning experience is reinforced, with motivation arising from activities being neither tediously easy nor frustratingly difficult.
- *"Satisfaction strategies" that provide extrinsic and intrinsic reinforcement for effort*—here, it is suggested that learners become more motivated to pursue a goal if achieving it will result in some kind of reward.

Analysis

With all of these requirements in mind, we can now attempt to compile a single list of key requirements for an educational environment. Table 1 shows a potential, more conclusive list, along with the papers from which the requirements were taken. The table suggests that the most important features of an educational resource are the ability for learners to explore contextually relevant environments, learner-instructor conversation, the opportunity for learners to integrate new knowledge with existing models, and the option for instructors to offer feedback on student activities. Now that we have this list, we can begin to use it to assess the suitability of mini-games as educational resources.

In order to evaluate the different educational qualities offered by mini-games, around thirty games were selected from the BBC Schools website. These games were selected across various topics, including history, science, languages and mathematics. In addition, games were selected from a range of different types, from simple number puzzles, to intricate reenactments of historic battles. Aside from stating clear goals and providing token rewards (such as a "Well Done!" screen on completion), the simpler word and number puzzles covered almost none of the requirements established in Table 1. However, some of the more complex games were more successful in fulfilling these requirements, with details of three of the more interesting cases presented here.

Criterion	Laurillard	Koper and Olivier	Merrill	Paras and Bizzocchi	
				Norman	Keller
Allow conversation between instructor and learner	X	X		X	
Demonstrate new knowledge to the learner	X		X		
Allow instructor to establish experiential, explorable environments that are contextually relevant	X				
Provide opportunity for learners to explore these worlds	X	X	X	X	
Allow instructors to provide feedback on learners' actions	X	X		X	
Provide customizable balance between boredom and frustration		X		X	X
Provide the learner with explicit goals				X	X
Allow the learner to integrate new information with their existing knowledge	X	X	X		
Motivate the learner by provoking curiosity				X	X
Promote a sense of immersion within the environment, free from external distractions				X	
Offer rewards when goals are achieved successfully				X	X
Unite a number of learning resources in a single environment		X			
Support blended and full online learning		X			
Allow the full pedagogical meaning of data to be expressed		X			
Be compatible with different standards		X			

Table 1 A list of requirements harvested from previous work, along with the papers from which they were taken

Death in Rome

This game surrounds the investigation of a mysterious murder in ancient Rome. The game is presented in a classic “point-and-click” adventure style: a detailed, static backdrop with various “hot-spots” scattered around it. These spots relate to objects of interest within the scene, allowing the player to pick up, use or further investigate them with a click of the mouse. This manner of investigation, combined with the murder-mystery scenario works well in provoking curiosity in the player. By keeping the player intrigued, their level of motivation is increased, leading them further into a state of “flow”. The way in which different clues “cross-reference” is also an interesting way of helping players to assimilate new knowledge into what they already know. Because the player needs to understand each clue within the context of all other clues, this mechanism forces the player to integrate the new information into their persistent mental models. Also, despite its two-dimensional nature, the environment and its contents are still “explorable”, with contextually relevant artwork helping players to immerse themselves in the information provided. Again, this immersion is useful in reducing the impact of external distractions, thus improving the “flow” state and the potential for learning.

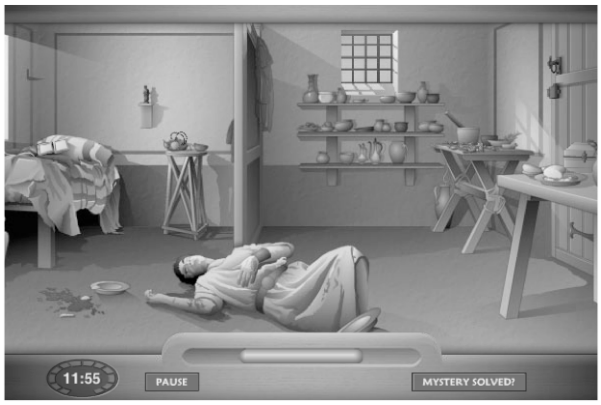

Figure 1 The murder scene in “Death in Rome” (taken from BBC Schools)

The player’s goals are set out clearly from the offset: find sufficient clues within a specific time limit, in order to make a confident deduction about the cause of death. With these goals established, the player is able to discover new knowledge within the scene without the frustration of trying to deduce these goals by themselves. In addition to the information found by clicking on the objects, the player is able to ask “experts” further questions. These “experts” are either historians, or roman citizens, who provide supplementary information on in-game items at the player’s request. This mechanism is useful in two ways. Firstly, it allows the full pedagogical meaning of the objects to be expressed, without overwhelming the player by showing it all at once on the main screen. It also means that the player is never forced to read the additional information—they need only look at it when they need to fill gaps in their knowledge. This provides an interesting balance between boredom and frustration, promoting a state of flow while offering help only when it is truly needed.

Pyramid Challenge

Here, the player is given control of the arrangements surrounding the construction of an ancient Egyptian pyramid. Everything from the choice of site, to the materials used, to the types of workforce is left in the player’s hands.

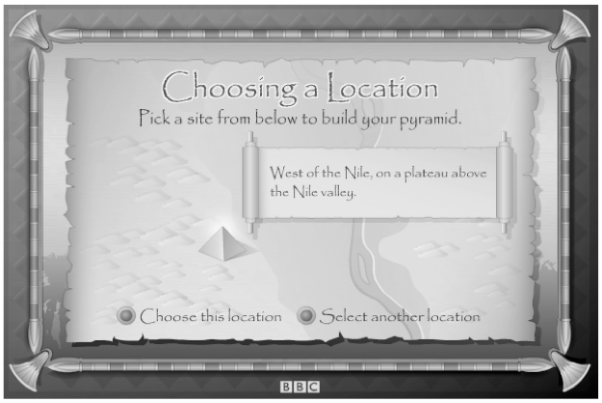

Figure 2 Choosing a building site in "Pyramid Challenge" (taken from BBC Schools)

On the surface, the game seems as well designed as Death in Rome, with detailed, relevant artwork, and a reasonably well defined long-term goal ("build a pyramid"). However, on actually playing the game, we see that many of the qualities found in Death in Rome are missing from Pyramid Challenge.

The first problem can be seen in the lack of new knowledge presented to the player. Where Death in Rome essentially had one question ("who was the murderer?") and a wealth of new information, Pyramid Challenge asks far more questions without providing anywhere near as much information. Where new information is given, it is often insufficient to allow the player to make informed choices. For example, when selecting a site for pyramid construction, details of the site's location, terrain and convenience are given. However, no clues are given as to how these details relate to the plight of a pyramid builder, making it difficult for the player to contextualise the new information efficiently, and therefore to assimilate the new knowledge into their existing cognitive models. There is also no real incentive for the player to integrate this limited new knowledge into their existing models—for example, once a site has been chosen, it makes no difference to what size of pyramid the player builds, so why should they bother to factor the site location into a persistent mental model?

Curiosity and immersion are also lacking thanks to the game's design. Where the player was able to explore a room in Death in Rome, in this game, the player simply responds to a series of question prompts, as and when they appear. There is no room for exploration, no world in which to be immersed. The staccato nature of the prompts, combined with a complete lack of potential for exploration makes it very difficult for the player to experience a flow state, making them less likely to pursue learning in the games without any external provocation.

A short, arcade-style boat-driving section is included in the game, possibly as motivation ("play the game, have fun driving a boat"), possibly as a reward ("you've completed this much of the game, now have fun driving a boat"). Whilst the provision of rewards is highlighted as a good idea in the taxonomy, the way in which this implementation offers no pedagogical benefits can actually make it more of a hindrance. By making such a detached section of the game seem like the "fun part", it infers that the rest of the game (where any actual learning takes place) is the "boring part", somewhat missing the point of using games to benefit education.

The Battle of Waterloo

As the title suggests, this game aims to simulate the actions of the Battle of Waterloo. Viewing the battlefield from an isometric, overhead perspective, the game works in a turn-based fashion with actions controlled by player responses to a series of questions.

The game demonstrates a good amount of new knowledge at the start of the game, with information regarding the army's campaign history and tactics being offered to the player. Whilst rich in its detail, the point at which it is offered could be better—once the game is started, the player cannot go back and look at the information, forcing them to remember it all if they want to succeed. This can be incredibly frustrating to the player, when they are faced with a decision they feel they could easily make, were they able to go back and re-read this material. When the player feels they are unable to progress, flow is interrupted, and the learning experience becomes less beneficial.

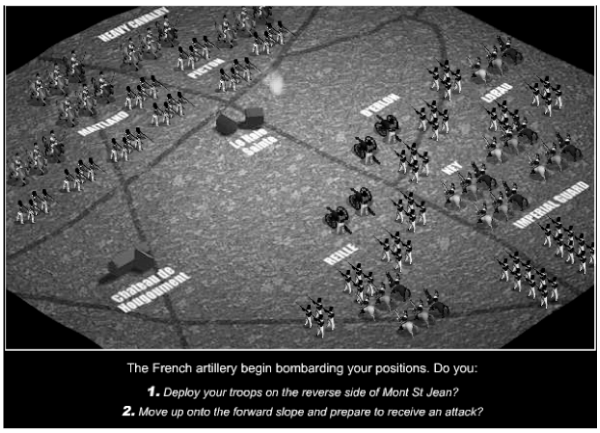

Figure 3 Troop deployment in The Battle of Waterloo (taken from BBC Schools)

The game mechanic appears poor in its provocation of curiosity, as well as in its balance of difficulty. Because the player is always presented with two tactical choices—one of them right, one of them wrong—they find themselves reluctant to experiment: by trying something different to the correct answer, they are guaranteed to lose. And because their only input into the games outcome is through this choice, there is very little room to balance the game—either the player knows the answer and they win, or they don't know the answer and they lose. Without provocation of curiosity or a balanced level of difficulty, two of the factors shown in Table 1 are missing, and the learning experience offered by the game becomes less effective.

However, once the game is completed for the first time, curiosity starts to build. What if the player were to go back and try a different tactical option? What if they were to fight the battle from the other side—and still win? In replaying the game multiple times and in different ways, the player can learn more about how military tactics of the era worked, helping them to contextualise the actual events of the real battle.

Conclusions and future work

The games described in this paper were selected for discussion because they exemplified many of the qualities and shortcomings of the investigated mini-games. Having analysed these features, some useful conclusions and recommendations can be made.

With a few exceptions, the games seem to be either too short or too shallow to offer any real sense of immersion. Many of them rely too heavily on question prompts, creating a layer of separation between the player and any immersive in-game content. Death in Rome was selected for discussion as it is a good example of mini-game immersion done well: a single, richly defined room creates a much more immersive experience than an entire vaguely defined empire, kept at arm's length.

None of the mini-games provided any opportunity for conversation or feedback. While perhaps the games are too short for much conversation to be required, assistance with feedback would certainly be possible. Due to the games' simplicity, it should be relatively easy to capture all of the player's significant moves, before collating them in a standard format. This could help instructors assess how well the players interact with the game, allowing them to alter it to better suit their teaching goals.

None of the games really managed to "unite a number of learning resources in a single environment", possibly due to being too short. But if we consider a mini-game to be a resource in its own right, could there perhaps be benefits from uniting a number of different mini-games, incorporating different gameplay mechanics which focus on a single learning topic, into a single compendium? That way, the overarching compendium becomes the game, uniting a number of mini-game resources to better express the pedagogy of a single area.

In addition, by putting multiple mini-games into a series, learners could be helped in their assimilation of new knowledge into their existing mental models. Currently, mini-games are so short that there is often little incentive for learners to contextualise any new knowledge they acquire. But if that knowledge were required in a later "episode" in the series, players would have to reconsider the old knowledge within the newly presented context, reinforcing the integrity of their mental models.

It may even be possible to go one step further, and unite the mini-games as "quests" in some Massively Multiplayer environment. In doing this, the social benefits of the MMO genre could be harnessed in the central "hub" world, while flexible, lightweight mini-games act as the gameplay focus on the peripheries. This would allow instructors to factor the gameplay portions of the system into their lessons more easily, whilst still retaining the collaborative, social benefits of the Massively Multiplayer hub.

The issues regarding insufficient or untimely provision of information could perhaps be resolved using blended learning. By providing supplementary information with books, lectures and in-class discussion, the mini-games can be kept lightweight, making them more flexible in their development and classroom use.

It can be seen that mini-games have a lot to offer, and some cases can cover almost all of the educational requirements proposed. But in their current state, most games fall short of the mark, in their lack of information, their formulaic gameplay, or their failure to provide a context for their content. By implementing the changes proposed, these mini-games could become the lightweight, flexible gaming solution that educators have been waiting for.

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PAPER 1146

Searching questions, informal modelling, and massively multiple choice

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Abstract

The Intelligent Book project aims to improve online education by designing materials that can model the subject matter they teach, in the manner of a Reactive Learning Environment. In earlier work, we developed mathematical proof exercises that used an automated theorem prover to model the student's proof. By observing human tutorial sessions, however, we find that this level of formal modelling is not necessary for many proof questions. In this paper, we investigate whether less formal modelling can still provide a useful Reactive Learning Environment. We constructed a system that uses search and informal reasoning about prewritten statements to ask questions for an undergraduate Discrete Mathematics course. When generalised and simplified, we find these search-based questions can also be used as a replacement for multiple choice questions, or to provide "massively multiple choice" questions.

Background

The Intelligent Book project aims to improve online education by designing materials that can model the subject matter they teach. For example, a question we designed for electronics asks students to choose current, voltage, and component values for a transistor amplifier, in order to meet a set of specifications (Billingsley, Robinson, Ashdown, and Hanson, 2004; Rehman, Billingsley, and Robinson, 2006). The question is backed by an AI model of the circuit based on a *constraint propagator* (Stallman and Sussman, 1977). Whenever a student sets a value in the circuit, this constraint propagator uses the rules of electronics to deduce what other values in the circuit need to be. If the student's choices are inconsistent or do not meet the specifications, the question can play back the sequence of deductions in the model, to explain to the student exactly what the problem with his or her choices is.

It is important to note that unlike *Intelligent Tutoring Systems* such as Andes (Conati, Gertner, and VanLehn, 2002) and *Intelligent Learning Environments* such as ActiveMath (Melis, et al., 2001), our exercises generally do not keep a student model measuring the students' understanding of particular domain rules or the solution steps they should take to answer a question. This is because as a research objective we wish to support questions where students are not taught the exact process used to answer the question (for example Higher Mental Process questions), and questions where there may not be a general process that solves all problems in the domain. In these cases, there are no known solution steps to model students against, and it is not the students' knowledge of basic domain rules that is being tested. Instead, our questions are designed as *Reactive Learning Environments* (Brown, Burton, and Bell, 1975). They give students the freedom and opportunity to try out

their ideas, and use the AI model of the material to explain any consequences or problems with their answers.

In earlier work (Billingsley and Robinson, 2007) we designed a set of proof exercises for a first year undergraduate Discrete Mathematics course that used the Isabelle/HOL (Nipkow, Paulson, and Wenzel, 2002) automated theorem prover to model and analyse the students' proofs. To overcome the difficulty that novice students with no programming experience would find Isabelle/HOL's proof language too complex to learn quickly, we used a very specialised interface where students composed proofs by plugging together tiles of mathematics that resemble what they might write on paper. However, in our trials we found that while we were able to make automated proof more accessible to novice users, a number of usability issues still remained. Some of these related to the fact that automated proof systems as well as being very formal also appear much more pedantic than a human tutor would be because they have a different understanding of what makes a reasoning step "trivial". Another difference in reasoning comes from the fact that a human tutor already knows whether the goal statement of the proof is true, whereas an automated proof system does not.

From these results, and from observing students answering proof questions in front of human tutors, it became apparent that a less rigorous AI model might be more useful for many of the questions in the course. The theory that we are working from, then, is that knowing something about the expected answer can allow us to model questions more loosely while still providing a useful Reactive Learning Environment. We have constructed a system for informal proof questions that uses predefined statements, search, and informal modelling

The structure of this paper is as follows. We first give two brief pieces of context: a summary of the architecture of Intelligent Book questions, and a summary of the original formally modelled proof questions and the issues that arose from them. We then describe our classroom observations of students working with human tutors, and how this led to the design of the informal proof questions. We then further examine the informal questions, and show how they can be generalised to an alternative to multiple choice questions, or provide "massively multiple choice" questions.

The original (formally modelled) scenario

The original, formally modelled, scenario is described fully in another paper (Billingsley and Robinson, 2007), but it is summarised here. Students are asked to write a proof that will be processed into Isar (Isabelle/HOL's proof language), but that is written in a different language designed for the students. A screenshot of a proof in progress is shown in Figure 1.

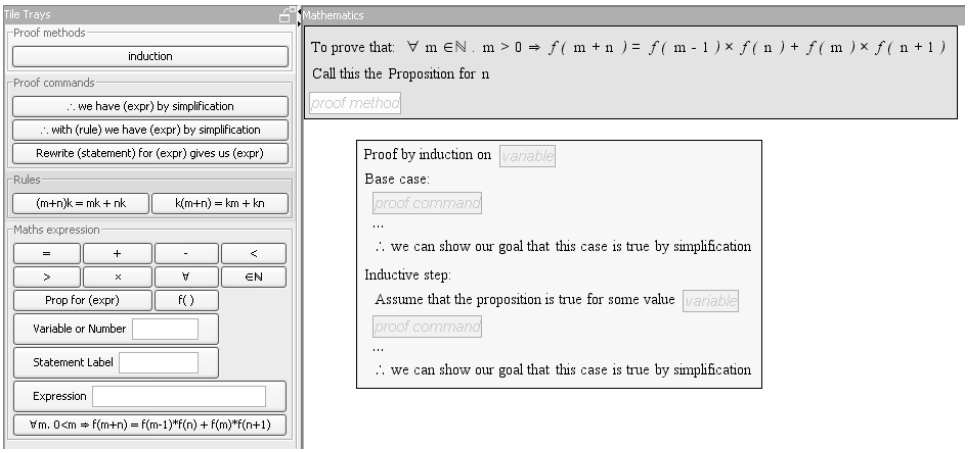

Figure 1 A proof being written using MathsTiles, that will be converted into Isar to check it for correctness.

Students compose their proofs using MathsTiles, which is a structured interaction language that we designed (Billingsley and Robinson, 2005). Tiles are added to the canvas by clicking the controls on the left of the screen. Alternatively, if the student types into an expression control, the tiles for the expression are automatically added to the canvas in a pre-constructed form. Each tile contains a piece of prewritten mathematics that can be as simple as a variable or an addition, or as complex as the structure of an induction proof. Sockets allow other tiles to be inserted into a tile—for example the plus tile has sockets for its left and right operands. The tiles essentially act as syntax templates, with the unusual features that the syntax and tiles can be different from question to question, and that students can scatter tiles or half-constructed tile structures on the canvas rather than having to work in a top-down manner. Internally, the proof is an XML document held in a Java applet in the browser, while a copy on the server is kept synchronised.

On the server, each question has a teaching script that describes how to analyse and respond to student actions. The teaching script can respond to any action the student makes on the client, but because checking the proof is a lengthy process (usually taking a few seconds), the proof is only checked when the student clicks the *Check proof* link in the browser.

To check the proof, the teaching script translates the MathsTiles document into the Isar proof language and runs it through Isabelle/HOL. The translation is defined by a *conversion script*. Conversion scripts are similar to XSLT in that they consist of a set of *matchers* that match particular patterns in the document (usually particular kinds of tile) and describe what output to produce. However, the conversion scripts are written in Groovy (a popular dynamic scripting language with similar syntax to Java), which also makes it easy to take procedural actions for some tiles, rather than only specifying the output.

The responses from the prover are read back into the teaching script, and post-processed to make them more understandable to the student. They are then marked up as annotations on the tiles that caused their output. The annotations are first marked as icons on the relevant tiles. Clicking on a tile causes its annotations to be shown in detail a panel on the right. A link beneath each annotation allows the student to ask for a further explanation of why that annotation was made, and in the case of errors, a second link asks the teaching script to make a suggestion on how to fix the error. Figure 2 shows a screenshot of an annotated proof.

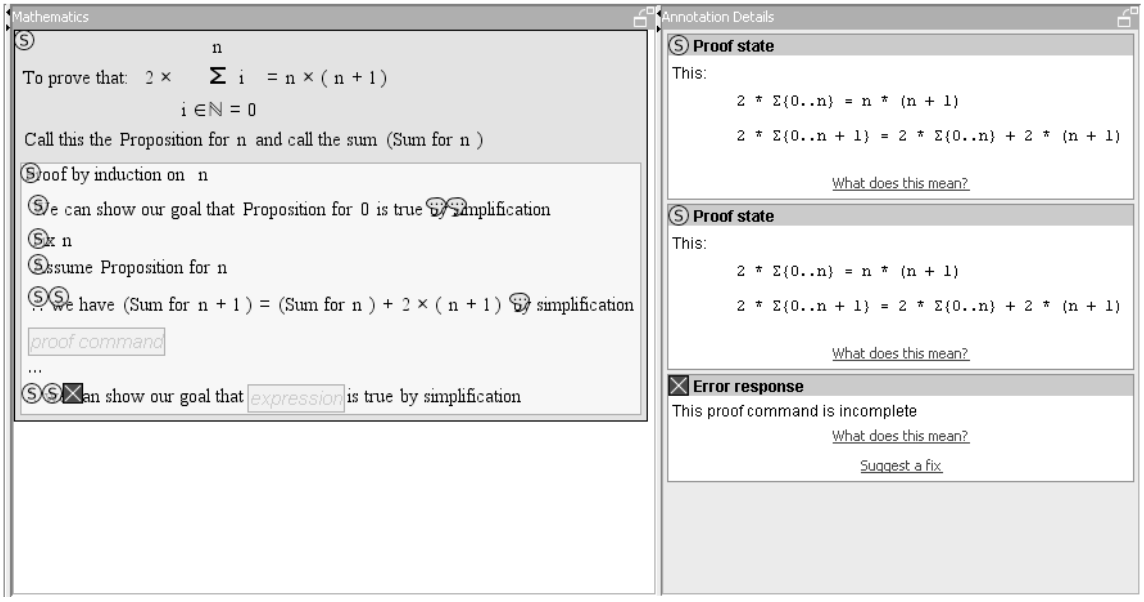

Figure 2 The tiles are marked up with annotation icons representing the responses from the prover. Clicking on a tile causes its annotations to be shown in detail in the panel on the right, together with links to further explanations, and links to ask the teaching script to make a suggestion on how to fix the error.

We performed a study using two kinds of qualitative usability analysis. First, we asked a number of users who had no experience of automated theorem provers to attempt six proofs using the system. Some of the users were students, and some were tutors of students. Participants were shown two short Flash videos to explain how the tile-based proof questions worked, and a worked example. The users' feedback, comments, and requests for assistsance from the exercises were coded against the Cognitive Dimensions of Notations Framework (Blackwell and Green, 2003). Second, two researchers who had worked closely with the system writing questions analysed the system against a Cognitive Dimensions Questionnaire.

Although some users in the study successfully completed proofs, which is more than we could expect if they attempted proofs directly in Isabelle/HOL with so little training, the study revealed a number of significant usability problems. Some of these related to simple oversights in the MathsTiles applet that are a straightforward coding exercise to fix (for example, the annotations often obscure some of the text on the tiles). Some of the usability issues, however, were more fundamental and relate to the fact that humans and automated systems have a very different notion of whether one line of symbolic proof trivially follows from another. For example, rearranging the order of an algebraic expression is often a trivial exercise for a human, but requires the combination of many different rules of algebra for Isabelle/HOL to check that it is correct. In fact there are approximately 1,500 rules that Isabelle/HOL's simplifier considers "trivial" in most questions, and this large number in turn makes it very difficult indeed for a student to know which rules Isabelle/HOL does not think are simple, and therefore must be mentioned explicitly in the proof.

Classroom observations

In 2005, we observed and video recorded a series of tutorial sessions in which students worked through homework exercises on the blackboard in front of their peers and a tutor as part of their Discrete Mathematics course. We observed 13 sessions, with four students answering questions in each session, in front of one of four tutors. Unsurprisingly, when students became stuck we observed that tutors would often try to guide them to the expected answer for the question, which was listed on an answer sheet held by the tutors. Surprisingly, however, we also observed occasions where the student found an unanticipated solution to the exercise (which was accepted) but the tutor still felt the need to explain what the expected solution on the answer sheet had been. This suggested that perhaps our ideal of giving equal support to every possible solution in an Intelligent Book exercise was unnecessary. Even human tutors, often found to be the ideal teaching scenario (Bloom, 1984; Kulik and Kulik, 1991), sometimes focus on an expected solution. This might in fact be the correct strategy—homework exercises are not usually set for the sheer beauty of setting a question, but to give the student experience in a taught area. Indeed if the question setter did not have a solution in mind, how would he or she have known that it was a reasonable question to set?

We also observed that many of the questions set in the mathematics course do not call for an answer phrased as a symbolic proof, but a more informal English language argument. For example, consider the following two questions from the tutorial sessions, together with their expected answers. (These answers have been rephrased slightly to make them more approachable for this conference's audience).

1. Show that the set of irrational numbers is uncountable.
    a. We suppose that the set of irrational numbers, $\mathbb{I}$, is countable and derive a contradiction. Suppose that $\mathbb{I}$ is countable. Every real number is either rational or irrational. That is, $\mathbb{R} = \mathbb{Q} \cup \mathbb{I}$. The set of rational numbers, $\mathbb{Q}$,

is countable. The union of two countable sets is countable. So the set of real numbers, $\mathbb{R}$, must be countable. But $\mathbb{R}$ is uncountable—a contradiction.

2. Show that any set of disjoint discs (ie, circular areas which may or may not include their perimeters and that do not overlap) in the plane $\mathbb{R} \times \mathbb{R}$ (a two-dimensional plane) is countable. You may assume that the rational numbers are dense in the real numbers, in the sense that for any reals $r_1 < r_2$, there is a rational q such that $r_1 < q < r_2$.
    a. Let D be a collection of discs in the plane. For every disk $d \in D$, we can draw a hypothetical square aligned with the x and y axis, such that the corners of the square lie on the circumference of the circle. This square has corners at (x_1,y_1), (x_2,y_1), (x_2,y_2), and (x_1,y_2). Since the rational numbers are dense in the real numbers, we have a rational number $q_d \in \mathbb{Q}$ such that $x_1 < q_d < x_2$, and a rational number $q'_d \in \mathbb{Q}$ such that $y_1 < q'_d < y_2$. The point (q_d,q'_d) certainly lies in the disc d.
    We now define a function $g: D \to \mathbb{Q} \times \mathbb{Q}$ as follows: $g(d) = (q_d,q'_d)$.
    Since the discs in D are disjoint, this function is an injection. Since $\mathbb{Q} \times \mathbb{Q}$ is countable and there is an injection from D to $\mathbb{Q} \times \mathbb{Q}$, D must also be countable.

Looking at these questions, there is little advantage to be gained from modelling the mathematics formally. We already know that the arguments, when constructed correctly, are formally true or otherwise we would not have set them as questions. So we are essentially looking for the students to say particular expected statements in the appropriate argumentative construct. The text of the second question appears more complex, and contains algebraic inequalities that look as if they could be modelled symbolically, but that would not be helpful. The inequalities are not used in any algebraic operations, but only to argue that because there are two distinct real x coordinates and two distinct real y coordinates on the disc, there must be a point with rational coordinates somewhere between them. (In fact, the original model answer had a slight mistake in the inequalities that went uncorrected for two years—this highlights that the algebra of the inequalities is not considered to be the important teaching point of the question.) Concepts such as drawing a square on the circle are awkward to model formally, but very easy to model informally as statements the student might say for this question.

For the tutorial sessions, the course planners explicitly asked students to explain the outline of their solution rather than focus on the specific algebra, but we also observed many similar questions in the course notes.

The informally modelled scenario

We built a system for asking these kinds of questions that uses an informal modelling system with the same MathsTiles front end as we had used in the formally modelled questions. Tiles are provided for prewritten statements that the student might mish to use in his or her answer. A screenshot of a question is shown in Figure 3.

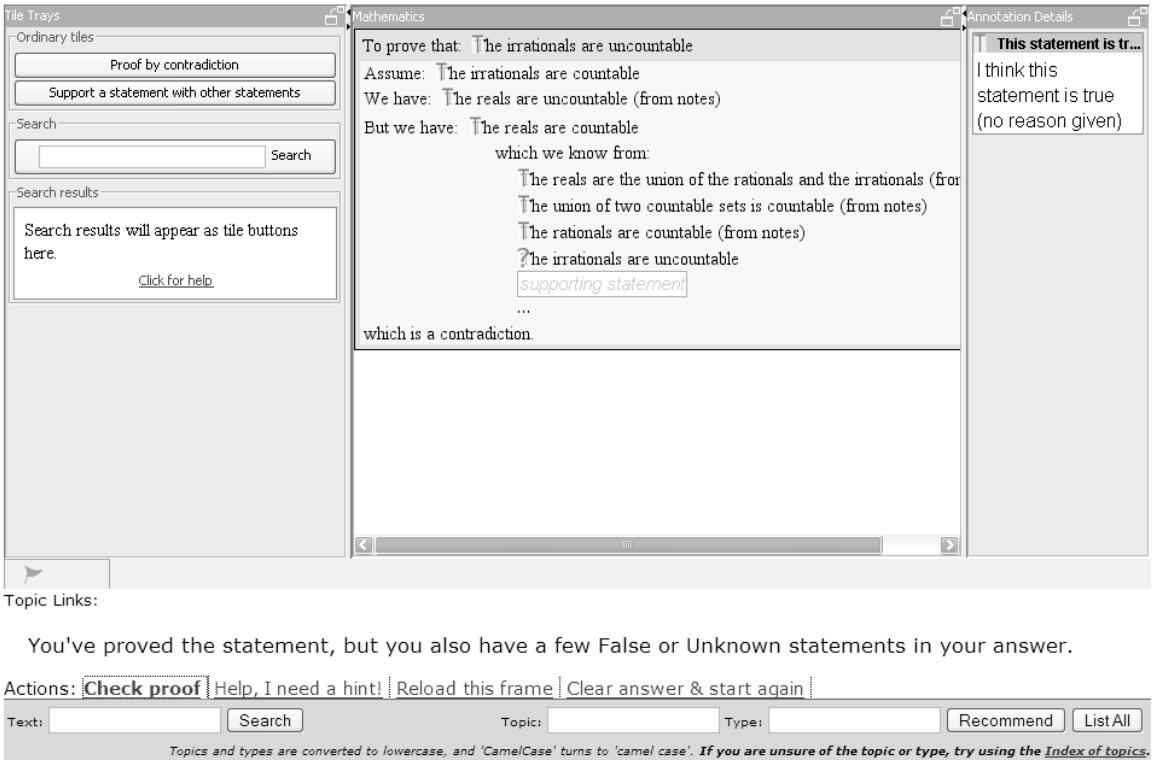

Figure 3 An informal proof question. Students argue using predefined statements that they must find using search functions.

If a list of the possible statements was made available to the students then the exercise would change from requiring recall to only requiring recognition. Students, rather than having to think of the statements they need to use in their argument, would merely have to recognise them from the list. Furthermore, students would be able to solve the question by simple trial and error—trying out different combinations of the available statements until the system was happy with the answer. To avoid this, the interface does not show the list of statements that can be used in the question. Instead we require students to search for their statements, forcing them to show they know something about the statements they wish to use. The search box is towards the left of the screen in Figure 3.

The search typed in by the student is required to contain a minimum number of keywords (normally two), and only tiles matching all the keywords in the search will be returned. The reason for this is to prevent very simple searches based on keywords in the question. For instance, if we allowed searches on a single term, then it would be possible for students to search for all the available statements about the *real* numbers, or all the statements including the word *countable*. Requiring multiple terms makes this strategy less effective—statements often link concepts (eg, “the *union* of two *countable* sets is *countable*”), and if keywords are required for each concept then the student has to initiate the link between concepts, rather than finding linking statements in the list by accident.

The model used to keep track of the argument is a *truth map stack*. Each map in the stack maps statement IDs to either of the states *true* or *false*, and also remembers the reason why each statement is mapped to each state. A request for the truth of a statement will look for the most recent map containing that statement ID and return the associated state. Statements that are not in any of the maps are *unknown*. Maintaining a stack of maps provides a simple way for us to make temporary assumptions and reason about them. For example, in a proof by contradiction, we push a new map onto the stack and make the temporary assumption that a statement is true. Based on this assumption, we then prove further statements to be true, until

we find a contradiction that shows our original assumption must have been mistaken. At that point, we discard the top map from the stack, that contains our assumption and all the temporary conclusions we drew from it, and mark the original statement as being false in the map underneath. The *truth map stack* is illustrated in Figure 4.

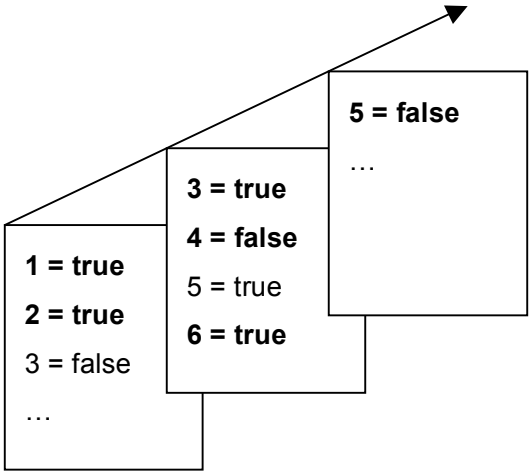

Figure 4 A *truth map stack*. Each level contains mappings from statement IDs to the states true or false. Maps can be added to the stack to temporarily override the existing mappings. Each mapping also holds a reference to the tile from the argument that caused it to be set (not shown).

The model is not driven by any automatic reasoning system, but by the argument that the student has written. The argument, as written in the tile language, forms a hierarchy of elements. Just as in the formal proof case, conversion scripts worked through the hierarchy to convert it into an Isar proof, so in this case conversion scripts work through the hierarchy. However, the output of these conversion scripts is not a document in another language, but a series of actions on the model. So for example, the matcher for *contradiction* tiles pushes the new truth map onto the stack, sets the statement in the tile's assumption socket to be true, and tests for a contradiction in its other sockets. In the tile language for these questions, users can only assume or conclude that statements are true. (False statements are dealt with by assuming or concluding that the opposite statement is true: users cannot argue that *"X"* is false but must argue that *"not X"* is true.) The test for a contradicton, then, is to find two opposite statements that are both true.

Writing a question involves writing the statements that the student can use, specifying their keywords, marking which statements are opposite to which other statements, and defining a set of implication rules. The implication rules state that a statement is true (or false) if a list of other statements is true. Implication rules can set statements to be false even though students can only argue that statements are true. The reason for this is to allow the list of statements returned by a search to include statements that are incorrect.

In these questions, we are essentially using predicate logic to model the argument and pre-writing statements for anything that requires a more complex logic. The system is, however, extensible beyond predicate logic—questions can include their own tiles and extend the conversion script to include their own matchers that implement the necessary checks.

Massively multiple choice questions

In the previous section, we discussed questions where you have to search for statements to construct an argument. In this section we briefly consider how this applies to questions where you have to search for a single statement.

Prewritten statements have the advantage over asking students to write their own statements that they do not need any complex parsing or checking. The “searching for statements” paradigm was introduced so that students would not be able to recognise and select statements to use from a short list. It is possible, then, to consider “searching for statements” as a compromise between the short answer and multiple choice formats. The number of options can be much larger than is practical in traditional multiple choice because the options do not all need to be shown at the same time, but is not the theoretically infinite number of choices that short answer format gives. For this reason, these can be considered to be *massively multiple choice questions* (MMCQs). We constructed a simple system for MMCQs, a screenshot of which is shown in Figure 5.

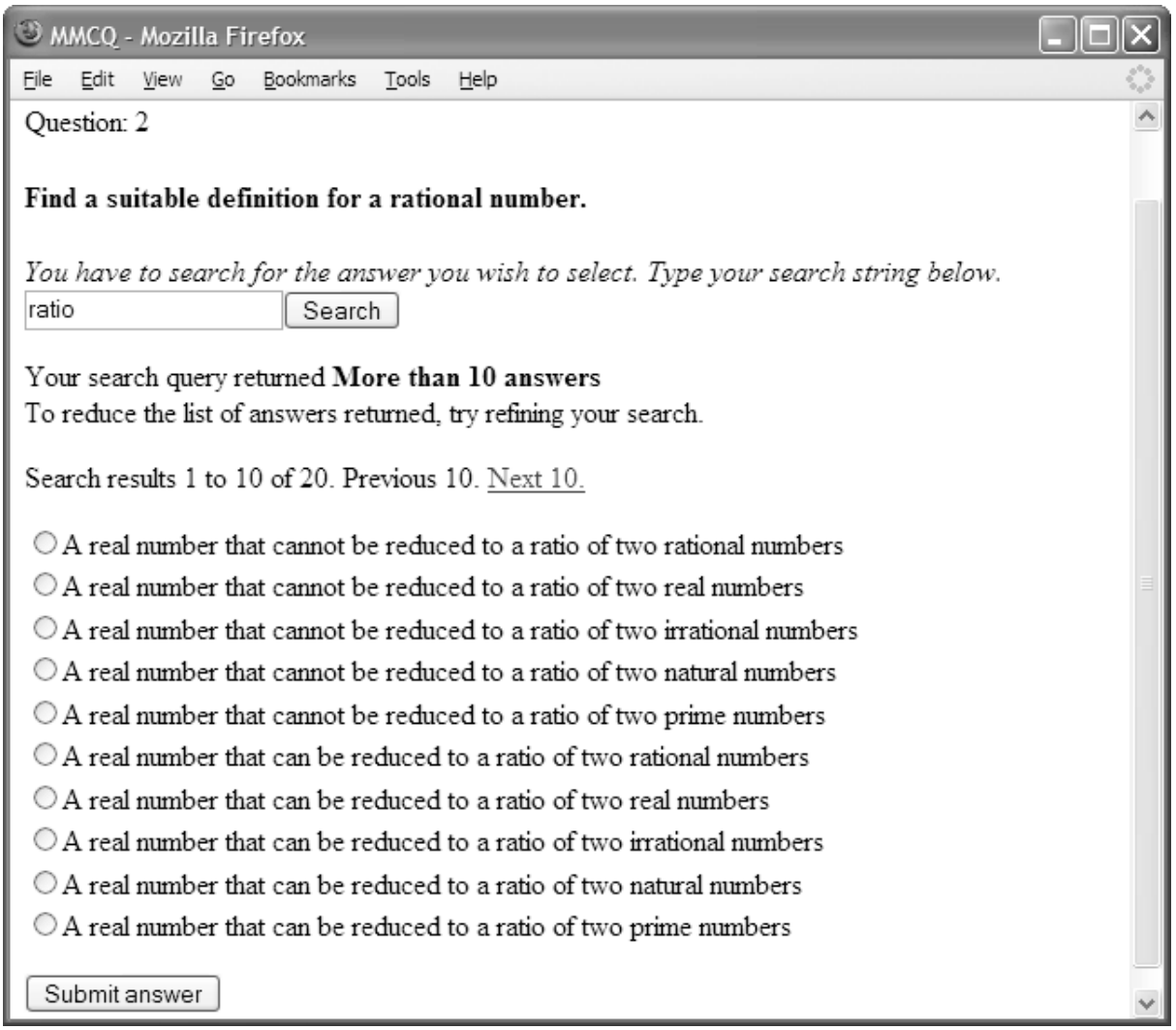

Figure 5 A “massively multiple choice question”—the student is required to enter a search to return potential answers, and then select an answer from the resulting list. The student has searched for “ratio”, so only answers including the word “ratio” are returned. (In this particular question students are not required to search for all or a miniumum number of terms in the intended answer.)

Again, these questions use the principle that knowing the probable answers in advance allows us to model the question more loosely. A more traditional approach would be to ask the student to enter a short answer and use Natural Language Processing (NLP) to analyse the answer. In this case because we already know what the student is likely to say, we effectively replace complex NLP with a simple keyword search and confirmation step.

The main advantage over traditional multiple choice questions is that the list of answers, being hidden, does not act as a prop. For example, consider the following mathematical puzzle (again from the Discrete Mathematics course) that does not work as a multiple choice question:

1. A prison houses 100 inmates, one in each of 100 cells, guarded by a total of 100 warders. One evening, all the cells are locked and the keys left in the locks. As the first warder leaves, she turns every key, unlocking all the doors. The second warder turns every second key, relocking every even numbered cell. The third warder turns every third key, and so on. Finally the last warder turns just the key in the last cell. Which doors are left unlocked and why?
    a. The key to cell number *n* has been turned once for every factor of *n*. So the doors left unlocked are those with an odd number of factors.

If the answer is visible on the page then respondents are likely to pick it whether or not they had thought of it before. If we require respondents to search for the keywords *"factor"* and *"odd"* before that answer becomes visible, however, then that would reasonably restrict that answer to only those who had already thought of it. Similarly, in survey questions hiding the potential answers may prevent respondents from being distracted from their original answers. It remains open to argument, however, whether this is a benefit or not—whether a response from someone who has not seen the alternatives is "a less well-considered answer" or "unaffected by suggestion". Nonetheless, just as there have been observed differences in students' responses to multiple choice questions compared to short answer questions (Pressley, Ghatala, Woloshyn, and Pirie, 1990), we expect students to respond slightly differently again to these questions.

Conclusion

Both systems have been implemented and used informally by students. Neither is obviously superior to the other, but they serve complimentary roles in teaching mathematics, because the two systems allow us to ask different kinds of questions. In the formal system we have tended to ask very symbolic questions, such as induction proofs of some algebraic statement on the Fibonacci sequence. These would be less well suited to the informal system because so many of the lines of the proof are algebra, and there is not a mechanism to search for algebra yet (although one could be imagined). The informal questions, as described before, focus on proofs where the argument is expressed in words. This makes it impractical to directly compare the usability of the two systems.

However, it is not simply the usability of the informally modelled questions that is their advantage—it is that it takes so much less development effort to produce a usable question. The conversion scripts and processing for the formally modelled system took several months of effort, and the Isabelle/HOL automated theorem prover that it uses no doubt took many PhD's worth of work for its developers to build. The informally modelled questions meanwhile were constructed over two afternoons, including their model.

There also appear to be two other advantages to a system using pre-planned answers:

- Students of mathematics take some time to become fluent in the formal language required for proofs. Allowing them to choose between syntactically correct but semantically different answers reinforces correct use of the language.
- Limiting the student to pre-planned answers using a simple model might also have another practical benefit. Often while there may theoretically be many routes to a proof, in a formal reasoning system there can be subtle reasons why some of the routes are very difficult to achieve. In a formally reasoned setting, students might spend a great deal of

time trying a theoretically possible but practically unachievable route to a proof. In a limited and informally reasoned setting, they will perhaps be readier to decide that a route is not supported and try another more successful strategy. Of course, further research would be required to verify this hypothesis.

Generalising the "searching for statements" mechanic to allow massively multiple choice questions is an obvious extension of the questions we developed. In pencil-and-paper multiple choice tests, there is a clear technical need for the options to all be shown to the student at the start. However, in the client-server situation that has been common in online learning for many years now, there appears to be no need to give away the answer in the question, nor to limit the possible answers to only four or five.

Acknowledgements

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PAPER 1148

Exploring students' understanding of how blogs and blogging can support distance learning in higher education

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Abstract

We focus on exploring students' understanding of how blogs and blogging can support distance learning in higher education. We report on the findings from a survey of 795 distance learners at the UK Open University, and interviews with course designers whose courses utilise blogs. Despite enthusiasm from educators, the survey revealed that students are not enthusiastic about the potential for blogging activities to be built into their courses. Analysis of students' open-ended comments revealed that some students have positive

expectations about blogging facilitating the sharing of material and ideas, for example, whilst the majority expressed concerns about subjectivity. We also discuss some empirically derived guidelines that we have generated that will enable educators to provide the appropriate scaffolds so that students can appropriate blogging tools for their own individual learning needs.

Introduction

We focus on exploring students' understanding of how blogs and blogging can support distance learning in Higher Education, with a view to informing course design and implementation. In recent years, new Web 2.0 technologies such as blogs and wikis have harnessed the social networking and community-building potential of the online environment (O'Reilly, 2005). These innovations enable sharing and collaboration between geographically remote users and offer the opportunity for new forms of student-centred pedagogic practices (Instone, 2005). There is widespread opinion that reading other students' blogs and writing your own blog can be beneficial for learning (e.g. Weller, 2007). However, previous research (e.g. Sade, 2005) reports that there can be significant challenges when using blogs in educational settings. Analysis of the challenge has tended to focus on students' technological abilities and/or their level of compliance with activities that have been designed by their teachers. It appears that little attention has been paid to exploring *students* preconceptions about whether blogs and blogging could support their learning. In the current project, we took a step back from investigating students actually blogging and explored the pre-existing perceptions that students have when they start a course that may include blogging activities. We report on the findings from a survey of 795 distance learners at the UK Open University, and interviews with course designers whose courses utilise blogs. We also discuss some empirically derived guidelines that we have generated to enable us to begin to address some of the issues raised.

Defining blogs and blogging

As part of the background to this research, a literature search was carried out to identify the ways in which blogs were being used and to identify any associated issues. This has made us aware that the terms 'blogs' and 'blogging' are often used interchangeably. We differentiate between blogs and blogging here; blogs are the static end-product of the activity of blogging. It is possible that students may have experience of reading other people's blogs, and/or experience of creating a blog (blogging) for themselves, or neither of these. Previous attempts to categorise a blog as, for example, a 'personal journal' or a 'filter blog' (Herring, Scheidt, Bonus and Wright, 2004) have been criticised as being unclear (Boyd, 2006). Boyd (2006) defines blogging as "a diverse set of practices that result in the production of diverse content on top of what we call blogs" (p1), which suggests that 'blogs' and 'blogging' can mean different things to different people. Undoubtedly, students' preconceptions about the utility of blogs and blogging to support their learning will be shaped by their level and type of experience.

Previous research

There have been several studies illustrating the potential for blogging to support learning. For example, students can use blogs to gather resources (Huann, John and Yuen, 2005) and share their materials and opinions with others (Williams and Jacobs, 2004). Also, blogging can support meaning-making (Fiedler, 2003) through reflective learning. Moreover, the development of knowledge communities through the exchange of hyperlinks (eg Oravec 2003), can foster the development of learning identities and reduce feelings of isolation (e.g. Dickey 2004).

Despite these positive examples of how blogs can be used to support learning, the perception of many students is more cautious. Krause (2004) reports haphazard contributions to blogs by his students, minimal communication between them, and found that posts demonstrated poor quality reflection upon the course materials. Williams and Jacobs (2004) introduced blogs to MBA students and although he reports overall success, he encountered problems with poor compliance as, for example 33% of the students thought they had nothing valuable to say in their blog. Similarly, Homik and Melis (2006) report only minimal compliance to meet assessment requirements and that students stopped blogging at the end of their course. Other issues include students plagiarising from each others' blogs, the need for students to have developed skills in choosing which hyperlinks to include in their blog (e.g. Oravec, 2003), and an ability to manage the tension between publishing private thoughts in a public space (Mortensen and Walker, 2002). These findings suggest that students are often task-focused and outcome oriented, that often they find it difficult to understand the rationale behind the requirement to blog, and that they are unable to recognise how blogging could enhance pre-existing practices. It appears that the ideals of educators can be difficult to implement in practice.

Theoretical perspective

As discussed above, it is difficult, if not impossible, to define the terms 'blog' and 'blogging', as blogging practices and products are extremely varied. Fielder (2003) argues that there is nothing intrinsic about a blog that directly facilitates learning. Essentially, a blog is a blank canvas surrounded by a selection of built-in tools that can be used in a variety of ways. Blogging is a contextually situated activity that is mediated by, for example, the tools available, students' opinions about its utility, course requirements and students' writing skills. We have adopted a cultural psychological approach to our research that proposes that learning is a social activity that is situated and mediated by tools that fundamentally shape the nature of that activity (e.g. Cole, 1996, Wertsch, 1991 and Vygotsky, 1979). Therefore, the focus of analysis becomes ''the individual functioning together with a mediational means'' (Wertsch, 1991, p 92). Here, we are focusing on students' perceptions of how they could function, together with blogging tools, to enhance their learning. If blogging is to be used in education, it is important for us to understand students' perceptions of its utility as this will enable us to provide them with suitable scaffolds so that students can appropriate the tool for their own individual learning needs.

The Open University context and our research focus

The UK Open University (OU) is currently implementing a £5m programme in which an integrated virtual learning environment (VLE) will be developed to meet the online learning needs of its 200,000 distance learners. The VLE will enable all courses to be designed to incorporate blogs, wikis and podcasting, as well as other asynchronous and synchronous tools.

The first aim of the study was to explore students' levels of familiarity with blogs and blogging and to understand their perceptions of the utility of blogging to support their learning. The second aim was to understand the pedagogical objectives behind OU course designers making blogging available on their courses. This would enable us to identify any discrepancies between students' and teachers' perceptions so that we can generate guidelines to facilitate students' appropriation of blogging tools. The research questions we sought to answer were as follows: 1) what degree of blogging experience do students have? 2) Do students want to have blogging as part of their course? 3) In what ways do students think blogging is (not) a useful learning tool? 4) Is there a disparity between what course designers *think* blogging is useful for, or *would like* blogging to be used for, and students' opinions of usefulness?

We report part of the findings of a survey completed by 795 OU students which was designed to ascertain their level of experience of blogs and to gather their opinions about how blogs (and other tools) could support their learning. We also report on interviews with course designers who are currently using blogs on their courses. Finally, we propose some suggested guidelines for both students and course designers.

Methodologies

Given the mismatch between the perceived educational value of blogs and the actual reported use of blogs in practice, we wanted to gather evidence of both students' and teachers' experience, perceptions and expectations of blogs to support learning.

Survey of students

A survey was developed by the Online Collaboration and Communication Project of the OU's Virtual Learning Environment Programme and sent to 1,893 OU student volunteers. The sample was stratified based on the OU population for gender, age, and region. The mean age of the students was 43.5 years (range 18–82 years). Fifty-nine percent were female and 41% were male. The survey was sent out on the 4th October 2006 and responses were gathered online until 23 October 2006. There was a 42% response rate (n=795). Most of the students had experience of learning on distance education courses where email and conferencing (primarily text but also some audio) had been used. The survey was designed to ascertain student attitudes and opinions towards asynchronous online conferencing, email, blogs and wikis. All questions required students to select their response by clicking on a radio button, (e.g. 'yes' or 'no', or Likert scales such as 'not at all', 'slightly', 'in-between/no opinion', 'fairly', or 'very much'). We were keen to enrich our data so some questions gave students the opportunity to elaborate upon their responses by typing their own open-ended comments into a text box (e.g. 'could you expand on your answer, giving reasons?').

Interviews with course designers

Semi-structured interviews were carried out with one faculty member from each of five course teams that each developed an OU course that gave students the option to blog. Four of the courses were at Masters level and were designed for professional educators in the field of e-learning, and one course was for pre-undergraduate students with minimal or no experience of internet tools. Interview questions were designed to address the following areas: the rationale for introducing blogs, whether blog content would be assessed, whether blogging was compulsory, uptake levels and whether there were any plans to evaluate the success of blogging activities. The interviews were audio recorded.

Analysis

The survey generated both quantitative and qualitative data. Radio button responses were collated electronically and analysed in SPSS. We explored the qualitative data (typed comments) by adopting a grounded theory approach (Glaser and Strauss 1967). Comments were manually coded in Excel and emergent themes were identified. We found that some students gave more than one response e.g. 'I think blogs are good for sharing ideas and make me feel less lonely'. Comments like this were allocated two codes ('sharing' and 'reduces isolation', in this case). The occurrence of each code was then counted so as to give an indication of the frequency of each type of comment.

Those codes that were in favour of the technology in question (e.g. 'sharing') were categorised as being 'positive'. Some students gave 'negative' responses e.g. 'blogs are

subjective, how do I know that they are right?'. Other students gave 'conditional' responses to some questions, e.g. 'a blog would be good *if* it were moderated'.

Similarly the themes from the course team interviews were extracted, collated and compared.

Findings

Survey findings: quantitative data

Survey responses indicated that 53.3% of students had read a blog and that only 8% of students had their own blog, suggesting that experience was mainly secondary. 17.3% had commented on other people's blogs and 23% of students thought that the commenting feature on blogs is 'slightly' or 'not at all' useful, 42% had 'no opinion' and 35% thought that commenting is 'fairly' or 'very' useful.

The whole sample were asked if they could see a role for blogs in their studies and only 18% said that they thought blogs would be 'fairly' or 'very' useful. Responses to this question were then filtered to include only those respondents who had said that they had their own blog (n=62). It is interesting to see that these students, who it might be expected would see a role for blogs in their studies, were not particularly enthusiastic for them either. Only 22% of blog owners could see a great use of blogs in their studies.

Students were asked 'how much would you like to use a blog provided by the OU as part of your studies?' Thirty five percent said 'not at all', 13% said 'slightly', 34% had 'no opinion', 12% said 'fairly', and 6% responded 'very much'

Students were asked 'how much would you like to use a blog provided by the OU for personal use?'. 52.6% said 'not at all', 8.7% said 'slightly', 28.3% had 'no opinion', 8% said 'fairly', and 2.7% responded 'very much'.

Responses to the question 'can you see a role for blogs in your studies?' were cross tabulated with responses to a question assessing frequency of accessing asynchronous online forums. Irrespective of the frequency with which students accessed forums, most felt that a blog would not be helpful.

Chi-square analyses revealed a significant relationship between responses to the question 'would you like to see a greater use of conferencing on courses?' and responses to *both* 'can you see a role for blogs in your studies?' (X^2=112 df=16 $p<0.001$) and 'how much would you like to use a blog provided by the OU as part of your studies?' (X^2=144.5 df=16 $p<0.001$).

Examination of the observed and expected frequencies for this data suggests that in both cases, there is a relationship between not seeing a role for blogs and not wanting greater use of conferencing. There is also a relationship between seeing a definite role for blogs and wanting a lot more conferencing.

There was also a significant relationship between not seeing a role for blogs and not finding an OU email account useful, and a relationship between seeing a role for both blogs and finding emails useful (X^2=69.6 df=16 $p<0.001$). A similar pattern of dependence emerged for wikis; there was a significant relationship between perceiving there to be a role for blogs and wanting 'very much' to use wikis, and a relationship between not wanting blogs and 'not at all' wanting to use wikis (X^2=227 df=16 $p<0.001$).

Survey findings: qualitative data

Students were invited to comment upon their responses to three questions about blogs. However, comments were very similar across all three questions so those related to the question 'how much would you like to use a blog provided by the OU as part of your studies?'

will be considered here. 188 students made 197 comments in response to this question. Response types, with frequencies and examples, are in Table 1 on the next page.

Positive responses

Table 1 reveals that all of the positive responses refer to the students' own (potential) study blog and how it could help them. Conversely, nearly half of the negative comments suggest that students may find the content of other peoples' blogs unhelpful (e.g. it is trivial and/or subjective). This suggests that blogs are perceived to be most useful when the blogger has control over the content and when they can communicate, through the blog, with other students.

Some of the positive responses suggest that many students perceive blogs to be *repositories* of material (i.e. ideas can be put there and/or events can be recorded there). The focus of these comments appears to be more on the end product (the blog) rather than on the process (blogging). The students' comments suggest that they have not considered how the process of blogging can help them to *create* the ideas and opinions that are recorded in their blog. Very few students mentioned, for example, how blogging tools could enable linking to web-based resources and how writing, in their blog, about the content of a resource can be reflective and aid the development of ideas.

It was also suggested that blogging could provide social support as well as support with learning. One student wrote that, *"because I am dyslexic I would like to communicate with others with the same problem. Also I am shortly to become a carer for my 95 year old mother when she comes to live with me*". This student could see blogging as helping her to feel supported and motivated in both her study and life as a whole.

Negative and conditional responses

Some of the students' negative comments suggest that blogs can be conceptualised as being an information resource compiled by others, that students can access and draw material from. The following excerpts illustrate this point (our emphasis added):

"I would certainly read it to see what it was like".
"If they give information or research material then I would use them".
"Assuming that, in this instance, the content [provided by others] will be subject to review/vetting as appropriate".

These comments probably reflect the fact that, as discussed above, most experience of blogs is gained by reading those created by others. It is interesting to note that these students did not seem to consider whether they would like to create their own blog.

Closely tied to this conceptualisation of blogs as being compiled by others, is the perceived problem of blog content being subjective or unreliable. This is a legitimate concern that can apply to a lot of the material available on the Internet. However, if a student made their own blog, with their own ideas, the issue of subjectivity may be less problematic. There were a number of students who said that they did not know how blogging could support their learning. One wrote that *"it appears that I am lacking in imagination here as I have not really got an idea about how Blogs* (sic) *can be at all relevant to studying",* and another suggested that *"it might detract from getting on with the work!"* Crucially, the latter comment considers blogging to be separate from work. This point is also exemplified in comments that suggest that the student would have no time to blog: *"I work full time and study evenings and weekends…I would be concerned that blogs would distract me rather than aid me"*. This student seems to consider blogging to be an extra activity instead of one that could become part of their study in the evenings and at weekends, which illustrates the importance of course designers justifying the usage of blogs to their students. Overall, many students appear to have a wholly understandable but nonetheless profound lack of awareness of how blogging can support learning.

Direction of response	Category of response (with example)	% of total comments
Positive	Non-specific positive endorsement ("It would be good").	21.8%
	Useful for sharing experiences, opinions, ideas etc: ("Might be useful as support, when the going gets tough you can share other people's experiences").	12.2%
	Reflection, recording the process/stages of idea development: ("Might be useful for tracking own progress e.g. this week I was stuck on X and next week I solved it").	3%
	Reduce isolation: ("It might help replace the interaction you would expect by attending a campus uni").	1%
		Total = 38%
Negative	What for?: ("I can't see how this would help me with my studies").	16.3%
	Not sure what blogs are and what they do and/or would like to have a go to find out: ("I would have to see how they might be applicable").	11.7%
	Would take too much time: ("I envisage that this could take up valuable time for dubious benefit").	11.2%
	Existing communication technologies make blogs extraneous: ("I'm happy with what is already provided and don't see the need for blogging to be involved").	6%
	Content is trivia: ("I find blogs in general self obsessive and quite frankly mostly embarrassing").	4%
	Other (small number of students): (Content too subjective, lack of privacy, poor organisation of material)	3%
	Don't like the medium: ("I use an A6 hardback notebook and pen that rarely crashes").	2.6%
		Total = 54.8%
Conditional	It would depend on the course: ("Depends on the type of course I was studying").	5%
	If they were moderated: ("It would really depend on the quality of the posts and/or moderation").	2.2%
		Total = 7.2%

Table 1 Responses to the question 'would you like a blog provided by the OU to support your studies?

Interview findings

Analysis of the interviews with course designers suggests that their pedagogical objectives were to provide students with an opportunity to explore blogging. The Masters students were encouraged to try blogging and to consider whether it could become a useful part of their professional teaching practice. On the Masters courses there was a strong expectation that blogging could aid reflection and the sharing of ideas with other students, and some of the course materials suggested blogging activities of this nature. Blogging was optional and the material assessed only if the student chose to use it in their assignments. Blogging was compulsory in the pre-undergraduate course and various activities were assessed. This was because the course aim was to introduce students to new technologies through participation in structured activities (e.g. posting to a blog and making a hyperlink).

Discussion

We have found that the OU students in our sample had varying degrees of experience of blogs and blogging, with around half having read a blog and a small minority (8%) having their own blog. These findings suggest that many students will need advice about the role of blogging tools and how their use of them could benefit their learning. Responses to the question 'would you like a blog provided by the OU to support your studies?' reveal that there is a profound lack of enthusiasm (from 82% of the sample) for blogging as part of courses. Arguably, the most interesting finding is that 88% of blog *owners* cannot see a role for blogs and/or blogging in their studies. These findings suggest that, although educators recognise the potential for blogging to support learning, most students do not agree. It seems that Boyd's (2004) definition of blogging as including a "diverse set of practices" is not interpreted, by many students, to include activities to support formal learning.

Our analysis of the students' open-ended comments revealed that nearly 38% could be categorised as being in favour of blogs. The disparity between this finding and those discussed above may be due to the fact that some students who selected a radio button to indicate that they had 'no opinion' then wrote a comment that could be categorised as being in favour of blogs. This gives rise to the question of whether or not the suggested benefit was perceived to be of any substantial additional value. These findings suggest that students need to be made aware of, or to discover for themselves, whether and how they could benefit from blogging, over and above their use of existing technologies to support their learning.

Some of the negative comments expressed concerns about the quality of blog posts as they may express "subjective opinions" and the information may be "inaccurate". However, we have noted that these comments refer to the content of *other peoples'* blogs. We argue that these issues are important also to bear in mind when constructing *your own* blog. Students will need advice and guidance about how to select resources to add to their blog and which RSS feeds to subscribe to, for example. These information management skills are as important, if not more important, as posting text to a blog.

Interviews with course designers revealed that Masters students were given an opportunity to explore blogging for themselves and to decide whether it could help in their studies and professional lives. Only one pre-undergraduate course used structured blogging activities, as the aim of the course was directed more towards learning how to use blogging tools. The difference in the approaches of these two types of course is important as it illustrates that the maturity of the learner has to be borne in mind when thinking about blogs, from both technical and learning perspectives. It may mean that the perceived gulf between students' and teachers' views of blogs and blogging may be variable. Some OU students in the survey had never heard of a blog, whilst others had their own blog, suggesting that guidelines need to be developed to meet the needs of a wide range of abilities.

Findings from the current study have enabled us to generate the following suggested guidelines:

1. Students will need easy-to-understand manuals about how to use the features of the blogging tool provided, and accompanying explanations of what the tool enables them to achieve and why they might want to explore it.
2. They may need advice about how blogging could replace some of their current study activities, and the advantages it offers over pre-existing methods and technologies. If blogging is to be adopted, students should be encouraged to make it an integral *part of* their learning and not an additional time consuming activity. Students may therefore need to think about what their current approach is, and whether/how blogging can enrich or remediate it.
3. Students may need a variety of modelled activities, with accompanying rationales for their utility, which they can explore for themselves.
4. Students may need to be made aware of how blogs could be used as distinct from email, forums or wikis, within the pedagogy of each individual course.
5. Blogs could be used to discuss and share existing course materials and/or additional resources that are found on the web. In both cases, students may need to be directed to resources and advice about how to manage this material e.g. archiving and assessing its relevance and accuracy. Students may need to be directed to external freeware to aid their archiving and use of RSS feeds to keep track of new posts to other blogs or web pages.
6. Tutors may find that regular moderation of the content of students' blogs, by posting comments about the suitability of weblinks or the accuracy of understanding of course materials, for example, may help overcome concerns about the subjectivity and accuracy of content.

This research has made an important contribution to understanding the potential of blogs and blogging in online learning and should be of interest to both educators and students. We are continuing to work towards the development of additional empirically derived guidelines. To this end, we are currently engaged with some Masters students who were on a course where blogging was optional. We are analysing the content of their blogs and carrying out follow-up interviews with the students. We are also undertaking similar research activities with some OU students who have started their own blog independently. We hope that this will enable us to identify the ways in which students find blogging useful, and the activities they engage in. Later this year, we plan to explore PhD blogs. This variety and combination of methods will enable us to gather different perspectives and to triangulate our findings. Future work, together with that discussed above will increase our understanding of the type and amount of support that educators and students may need when utilising blogs and blogging in courses.

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PAPER 1150

Postgraduate blogs: beyond the ordinary research journal

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Abstract

The study described in this paper investigated ways in which keeping a research journal as a blog rather than as a paper document influenced the postgraduate student research experience. Four blogs (three individual and one collaborative blog) initiated by three research students were used as the corpus of data. The three individual blogs acted as alternatives to the traditional research journal . The analysis indicated that blogs can promote a community where students are encouraged to reflect and share ideas, skills and research life idiosyncrasies. Blogs also acted as memory repositories and encouraged collaboration amongst the research students.

Background and theory

Learning is a participative activity, a transformative process which takes place in a social setting (Mezirow, 2000). Socio-cultural researchers built on the work of Vygotsky and demonstrated that "*communication, thinking and learning [are] related processes which are shaped by culture*" (Mercer, 2004). Learning is thus a community activity, a process of co-construction of knowledge.

Wenger (1998) demonstrated the ubiquity of communities of practice, showing that individuals learn as they engage in and contribute to the practices of their communities. Johnson (2001) highlighted three key elements of such communities: different levels of expertise are present simultaneously, there is a fluid progression from novice to expert, and the community engages in completely authentic tasks and communication. While groups provide opportunities for objective evaluation and cognitive stimulation (Benbunan-Fich and Hiltz, 1999); the interpersonal ties within communities increase the flow of information as well as the availability of support and co-operation (Haythornthwaite, 2006; Haythornthwaite, Kazmer, Robins, and Shoemaker, 2000).

As use of interactive media has increased, so has research into the ways in which learning and communities may be supported within an asynchronous and largely textual environment. Asynchronous communication has the advantages for learners that it is convenient, place-independent and time-independent (Wu and Hiltz, 2004). Asynchronous environments have the potential to enhance literate forms of higher order thinking, allowing group members to

incorporate many perspectives, to consider carefully crafted contributions and to construct their own learning experience by choosing what to read and in what order (Lapadat, 2002; Lapadat, Mothus, and Fisher, 2005). They afford opportunities for reflection and critique (Conole and Dyke, 2004) and they allow individuals time to make considered contributions (Hawkes, 2001).

One such asynchronous environment is the blog; "*a web-based space for writing*" (Armstrong, Berry, and Lamshed, 2004). Blogs are increasingly utilised in education by communities, academics and students (Weller, Pegler, and Mason, 2005). Brady (2005) describes some of the affordances of blogs, including the permalinks which give a blog a memory, and trackback which acts as a citation alert to authors. For Mortensen and Walker (2002), links are vital to the genre, providing researchers with tools to think about their research, its values, connections and links to other aspects of the world. In her reflexive study of research blogging, Walker (2006) found that "*the most important way my blogging helped my research was social*".

Blogrolls (lists of weblogs that an author reads regularly) reveal sources which influence a blogger's thinking and writing. Blogs offer individuals an opportunity to share thoughts, ideas and opinions and to work together, either by using the comment facility on an individual's blog, or by setting up a collaborative blog (Du and Wagner, 2005). Blogs can help to build trust within a community (Scoble and Israel, 2006). They can also support communities of practice by creating an environment in which people can observe, articulate and refine practices (Efimova, Fiedler, Verwijs, and Boyd, 2004).

In traditional classroom environments, learning journals written to be shared with a teacher have been shown to encourage reflection and to make students more metacognitively aware of their writing process (Cooner and Dickmann, 2006; Mahn and John-Steiner, 2002). Postgraduates are often required to keep personal research journals: as records, as memoranda and as vehicles for reflection (Blaxter, Hughes, and Tight, 2001; Cryer, 2000). Blogging has the potential to make the research journal interpersonal rather than intrapersonal, making it a catalyst which stimulates critical thinking and allows interested parties to articulate critical voices (Oravec, 2003). Burgess (2006) identifies blogs' potential to "*build the kinds of literacies that are appropriate to networked, technologised environments*". Some of the advantages of a blogged research journal over a traditional research journal are that:

> *From a junior scholar's point of view, blogging can be an excellent method for developing and sustaining a confident and clear voice of one's own and the ability to formulate and stand by opinions. While private journals may fill with notes, they need not be as clearly formulated as a post in a weblog (Mortensen and Walker, 2002)*

Despite these advantages, students avoid blogging if they do not see its value or if they see it as a waste of time. If they do blog, they need to be sufficiently mature to utilise their blog for debate and reflection (Anastasi and Cochrane, 2006). Students may also be concerned that a blog set up by an institution such as a university may be manipulated, regulated or closed down by that institution (Downes, 2006). It is important to clarify to students how to blog and what they can expect to gain from the experience (Williams and Jacobs, 2004). To do this adequately, educators need to know how and why students blog. This study provides answers to these question with regards to doctoral students, and addresses ways in which blogging can promote a sense of learning community and support the experience of postgraduate research.

Method

An investigation of the ways in which blogging a research journal might influence postgraduate research requires a set of authentic research blogs for analysis. Furthermore, signs of a developing learning community will only emerge through blogs that are linked in some way. Research journals are personal artifacts and although their use is encouraged by universities and individual supervisors, the manner in which they are maintained is up to the individual PhD student (Lillis and North, 2006). Even if a sample of research blogging PhD students could be located and permission obtained to use their research blogs as data, it is unlikely that the authors would be aware of the other blogs. The authors (PhD students in the same faculty) therefore decided to set up a study in which they used their own research blogs as data.

In November 2005, while in the first year of their PhDs, the authors set up a collaborative blog. This collaborative blog was intended to be a place where students could share information. Whilst it had three authors, access was not limited to that group. Additionally, two of the authors ([Author B] and [Author C]) had already begun individual research journal blogs. [Author A] began her research journal blog just before the collaborative blog was set up. Both [Author A] and [Author B's] blogs were intended to be dark blogs, with access restricted to a few selected people, whilst the collaborative blog and [Author C's]'s blog were open blogs, intended for public viewing. Charman (2006) defines dark blogs as "*blogs not accessible to the public because they are behind a firewall or password*". They are therefore not available for public viewing. Personal blogs may be set up as dark blogs by password-protecting them, or by creating an authentication list of people who are allowed to see them.

All four blogs listed the other three blogs in their blogroll. This enabled each participating student to access the blogs of the other students from their own blog. In addition, as the study progressed, the students began to use Google Desktop, enabling RSS feeds to notify them when their colleagues had posted something new.

Initially, the collaborative blog was expected to last only a year, but the research blogs were to continue until the PhDs were complete. When the authors set up the collaborative blog, they planned to investigate how it promoted a community of research and for this reason, blog entries were sometimes related to blogging literature. Thus, the purpose of the collaborative blog was to provide a forum outside the personal research blogs in which the students could discuss issues that were less closely related to their personal areas of research.

At the end of the academic year, when the collaborative blog had existed for 11 months, the authors began to research how the individual research and collaborative blogs affected the student research experience. All four blogs (see Figure 4) were therefore analysed for the same 11-month period.

Analysis of the collaborative blog began with a detailed consideration of the entries by all three researchers working together. This resulted in the creation of 20 categories. When the individual blogs were taken into account, several categories were combined or eliminated and others were added, creating 31 categories in all.

Blog	Type	Purpose	Time (yrs)	Main Topic	Host
Collaborative	Open	Collaborative blog	1	Student-related issues	Wordpress
[Author A]	Dark	Research blog	3	Learning in online communities	Initially AOL and then Wordpress
[Author B]	Dark	Research blog	3	Mobile technologies and informal learning	Initially Blogger then WordPress
[Author C]	Open	Research blog	3	Mathematics education and software	Tripod

Figure 4 Summary of the initial conception of the blogs and their purposes

In order to analyse the collaborative blog, a duplicate collaborative blog was made and the 31 categories were applied using the blog-post categorisation function provided by Wordpress. The three researchers worked together to code the collaborative blog. However, for the individual blogs, entries from November to January were categorised collectively. Subsequent months were coded by the blog owner. If categorisation appeared ambiguous it was cross-checked with the other two researchers to improve coding reliabilty.

The categorisation of the individual research blogs was recorded using an Excel spreadsheet. The week (beginning on Saturday) was selected as the unit of analysis, and the codings for all postings in a week were recorded together and totalled. This method was selected because [Author C's] individual blog was hosted on Tripod and could not therefore be copied and re-categorised in the same way as the Wordpress blogs. The collaborative blog categories were later added to the Excel spreadsheet for compatibility in analysis.

Contribution

The authors used many distinctive blog features that would not have been available with a handwritten research journal. Hyperlinks allowed them to link their research blogs to useful information sources, creating a knowledge network with the student blog at its centre. Emoticons and images were used to personalise blog entries, incorporating the essence of how the author was feeling at that time. Categories and a comprehensive search facility provided efficient information retrieval of postings throughout the lifetime of the blog. For example, posts relating to a single topic could be sorted and displayed in a coherent list by selecting a particular category, while entering a search keyword would display all posts containing that term. The blogroll, RSS feeds, trackbacks and permalinks connected blogs to each other creating a collaborative web in which each author was quickly aware of new posts written by other blog authors.

The 31 posting categories identified during coding were grouped into six overall themes:

1. *Community Posts* which demonstrated a high degree of interactivity and collaboration either between the bloggers in the study or between them and other members of their academic community.
2. *Reflective Posts* discussing research ideas, progress, methods, methodology, theoretical frameworks and academic writing.
3. *Environmental Posts* in which the group shared experiences of their research environment, or in which they introduced an element of physical context to the post by describing their immediate situation (noise, temperature, mood).
4. *Memos* which included both organisational posts listing things to do and remember, and links and references to external material and websites.
5. *Emotive Posts* which indicated how the author was feeling at the time, expressing such feelings as doubt, uncertainty or humour.
6. *Blogging-related Posts* which discussed blogging as an activity and as a tool for data analysis. These often highlighted the influence of the university's blog administrator through references to ways in which he could change or influence the blogs.

Most posts fell into more than one category or theme, for example, reflective posts would often also include emoticons to indicate the state of mind of the author at the time. The six themes are elaborated below.

1 Community posts

These blog posts demonstrated a strong interactive element. Interactions included requests for feedback, usually directed at the other two blog authors and responses to posts in the form of comments and feedback. Also included in this group were posts aimed at sharing skills, methods, methodology and other useful techniques. For example, in the collaborative blog, [Author C] described how useful she found Google Desktop, and outlined its features. [Author B] responded that she had heard about Google Desktop in the past, continuing "*…but I hadn't paid attention until I read this posting. I'm now hooked*".

The presence of a reader is implicit in most blog entries. Research journals are intended to be read by their author and by supervisors, but their readership generally ends there (Lillis and North, 2006). Research blogs may be read by their authors, supervisors, other students and, if open, by anyone who chances upon them. This potential readership turns the blog from a simple notebook into a more constructivist learning medium. For example a post by [Author C]'s reflected upon the presentations given at a seminar which triggered a comment from somebody who was not a member of the student blogging group. The commentator had also attended the seminar and used the commenting facility to add his thoughts to those in the original post, thereby elaborating the original discussion and offering an additional perspective. [Author C] continued the asynchronous discussion by responding with another comment.

Some posts were explicitly intended to be collaborative. These posts demonstrated a two-way communication, and support for a constructive approach to writing, that would not be possible with a traditional research journal. The blog authors posted drafts or outlines requesting and receiving comments and suggestions from their peers. For example, [Author B] posted ideas for research questions in her personal research blog, requesting feedback. [Author C] responded through the commenting facility. [Author B] then re-wrote the research questions as another comment in the thread, incorporating some of [Author A]'s suggestions.

The comment function was used in some cases to develop a conversation by responding to a blog post and asking questions about it. When [Author B] posted a summary of her week, explaining that she was still struggling to decide on a research question, [Author A] followed up, asking: *"Are you looking for an upbeat research question or for one that addresses a problem eg What are the barriers to collaborative mobile learning?"* This encouraged [Author

B] to consider the subject further: *"I'd rather go with a positive stance and see if I can field the critiques rather than focusing on the difficulties".*

Other interactions that were woven into many of the blog postings were references to contacts with individuals or communities by other means (face-to-face, email, forums). Reference to face-to-face interactions included posts reflecting on the supervisory relationship, both that of the three bloggers themselves and that of other students, and posts describing meetings with other academics and students. Email and forum interactions were sometimes mentioned and excerpts from these interactions included in the blogs.

The blogs acted both as repositories for information, tools for developing research skills and a medium for reflecting upon the interactions that constitute the student experience. They also tied the students into an academic community of practice over a long term in which they, as novices, could learn from experts both in person and through online contact. When [Author A] found something interesting in the blog of an academic from another faculty, she wrote it up in her own blog without being clear how it related to her research: "*Can't actually think what I'd do with it*". Another blogger commented that she had followed up the link and reported on her experience. Two months later [Author A] returned to the subject, *"I think this links to the HeatMaps that I blogged a month or so ago",* and went on to make theoretical links between the subject and her research. She noted that she had discussed the subject with fellow academics and, the following year, incorporated it within a presentation to her faculty.

2 Reflective posts

Reflective posts are those that would traditionally be included in a research journal (Lillis and North, 2006). It included posts exploring the wording and implications of potential research questions, those noting the emergence of new research ideas and further posts developing those ideas. Posts also included those in which the authors organised their thinking and reflected upon their research progress. Methodology, epistemology and theoretical frameworks were also discussed. Sometimes such posts triggered a response, sometimes they stood alone. However, the interconnectedness of all the blogs meant that all participants were aware of new posts.

Academic events were also mentioned; a student who attended an event would post her impressions and experiences together with relevant links or references. Students unable to attend the event could add to their knowledge by reading these descriptions. Sometimes these posts were explicitly written with the reader in mind, as when [Author A] posted a description of a conference event, saying "*This seemed to tie in very well with [Author B]'s mobile learning"* and going on to explain the connections.

3 Environmental posts

Some blog posts incorporated references to and descriptions of the research environment. This could be a direct reference to the physical environment, for example: *"I don't feel I'm very productive when it's as warm as this (27C)"*. Environmental posts could also take the form of comment on some element of the research environment. For example, some posts included evaluations of workshops and support provided by the university whilst others initiated discussions about elements of the university bureaucracy. Together, these posts built up a picture of life as a postgraduate research student which could be relevant not only to the students involved in the blogging group, but also to other postgraduate students.

These environmental postings also had the function of reinforcing memory. Recall of an event or of a train of thought could later be triggered by reference to an image, to music or to another aspect of the setting with which it had been explicitly linked within the blog.

4 Memos

Blogs provided useful locations for notes and memos that the students wanted to be able to access from any location. All the blogs were hosted on a central server and were therefore accessible from any computer with an internet connection. The blog served as a physical memory which could easily be searched either by category or by key word. These search facilities benefited not only the author but all a blog's readers.

One of the commonest types of post in both the individual blogs and the collaborative blog was the filter post, that is, posts containing links to external websites, references or recommendations of good blogs to monitor through RSS feeds. In this sense, the research blogs were used as a repository for useful links as well as a place in which to share knowledge.

5 Emotive posts

This group included blog posts which referred to or implied some form of emotion. Such postings involved the use of emoticons, images or graphics for emphasis. Included in this grouping were the categories 'Rants', 'Emoticons', 'Humour' and 'Self-doubt and uncertainty'. Key to the use of emoticons was the intention, on the part of the author, to provide some sort of context to the post, to explain it further. Implicit in this intent is the acknowledgement of the existence of a reader who may or may not be familiar with the author. The potential for emotive elements in blog postings is characteristic of blogging software and does not exist in handwritten research journals. Such posts serve to provide presence and make it clear that the authors are not just writing for themselves but also for readers who require both facts and the context which frames those facts.

6 Blogging-related posts

This theme included the reflexive references to blogging that occurred in both the individual and the collaborative blogs and included reports of interactions with the blog administrator. When the university blogs were set up, blog hosting was a new activity at the university and the blog participants negotiated and modified both the appearance and the functionality of their blogs through interactions with the system administrator. In some cases, the posts were designed to elicit expert help, while others considered the advantages and disadvantages of using a blog hosted by the university. [Author A] wrote

…this is an Open University research blog, so it won't close down if I leave AOL (though presumably it will close down if I leave the OU. However, as it's now in a more transferable format, I should be able to move it over to another site with fewer problems than making the move from AOL). Also, it should be easier to sign up new readers, including my supervisors.

7 Evaluation

The role of the blog as a medium to support the development of a community of practice was evident in many of the postings. The students were aware that they had a readership, and this influenced not only what they posted, but the ways in which they posted. Through the use of emoticons, images and posts containing elements of humour and the sharing of experiences, the students were able to define and maintain a supportive learning community. Posts expressing negative emotions, or 'rants' often triggered some form of comment or response. Posts expressing uncertainty or doubt received supportive feedback. In this sense, the blogs reinforced the support and co-operation whilst reducing feelings of isolation which are so important when building a community.

Communities of practice are characterised by members possessing different levels of expertise (Johnson, 2001) which they share with each other in order to progress from novice to expert. The students in the blogging group were all mature students at roughly the same

stage in their studies. However, as each was researching a different area and brought different skills and aptitudes to the community, some degree of skill transfer occurred as they shared links, references or experiences. In addition, the interpersonal links made possible by the blogroll made it possible for them to observe the practice of more experienced members of the academic community at many different institutions across the world.

The openness of the research blogs gave them a more collaborative character than traditional research journals, described as "*normally private documents*" (Lillis and North, 2006). It encouraged students to consider their posts carefully, supplementing them with hyperlinks and images where appropriate to direct and assist their potential reader. They thus supported the verbalisation and clarification of ideas to a greater extent than a written journal, while also providing immediate access to relevant sources. The asynchronous nature of blogging, and its support for communication and feedback, enhanced the potential for higher-order thinking and reflection. Authors could be confident that other people were reading and reflecting on their posts and that their learning would be supported by the comments of their readers either through the comments feature, via email or through trackbacks from other blogs.

The research blogs were used as tools to develop research ideas, share and locate information, access a worldwide academic community and obtain feedback and support from peers. They also served as a collective resource. By sharing information, each student could benefit from the experiences and knowledge of others. The blogs thus made visible elements of the process of the co-construction of knowledge.

Conclusion

This longitudinal study was successful in identifying ways in which postgraduate research students use blogs in order to build a community of practice, to enhance reflection and to improve their academic writing. The study revealed the distinctive features of blogs that enabled the students to use individual blogs as a form of physical memory, and collaborative blogs as a group memory. Research into blogs has often drawn on blogs set up specifically for the research project or blogs which have some role in student assessment (e.g. Weller, Pegler, and Mason, 2005). The current study is based on 11 months of four active blogs' postings and comments and therefore draws on a substantial and authentic data source.

Data was drawn from the blogs of three students from the same faculty, all interested in blogging and educational technology and all enthusiastic to post their research ideas and reflections in public. However, their faculty membership meant that they also had regular face-to-face contact. This gave them an alternative means of communication which may have affected the data collected from the blogs. Sometimes a blog post could generate a response in the form of verbal discussion which would eliminate the need for a comment or posting in the blog. Occasionally the results of these discussions were posted to the blogs, but some evidence of collaboration and social networking was necessarily lost. The research could be extended in future to include the use of research blogs by students who have no face-to-face contact, by students in other disciplines, or by students who have not previously used blogs.

The study demonstrates that blogging can support and extend the learning of postgraduate students. It is more than an electronic form of the traditional, written research journal in that it offers a range of new affordances which can improve the experience of the postgraduate research student. Universities should, therefore, offer a blogging facility to research students, supervisors should draw attention to the potential benefits of this method of keeping a journal, and authors of books on research methods should cover this area in some detail.

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PAPER 1163

The desires of digital students

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Abstract

Recent years have seen a new generation of 'digital students' emerging in the developed world. Digital students are young adults who have grown up with digital technologies integrated as an everyday feature of their lives. Digital students use technology differently from previous generations of students, fluidly and often simultaneously using instant messengers, mobile phones, the Web, MP3 players, online games and more. A study performed in a UK university was designed to identify and evaluate the use of new technologies, especially of social software, by digital students. The study is part of a research project which is investigating how the development of the e-learning spaces might be informed by digital students' attitudes. It was the first step taken towards the development and evaluation of a new learning environment for digital students.

Introduction

The last quarter-century has seen the digitization of virtually all aspects of life—something Negroponte has called the "change of atoms into bits and pixels" (Negroponte, 1996). However, for the generation born after 1980 the digital world is even more present and pervasive than for the rest of us: for them it is the only world they know. They are the 'digital' or 'Net' Generation (Tapscott, 1998): children or teenagers who have lived all their lives in a changing but (from their perspective) a predominantly digital world. Significantly, most students in higher education now belong to this group. We have identified these students as a special group due to their characteristics (Andone, Boyne, Dron, and Pemberton, 2005a) and we consider that this community has different learning habits from students of previous generations.

The article of faith that underpins out work is that technology makes it possible to design learning situations that actively engage and guide learners while allowing them to choose their style of learning and organize their knowledge outcomes. This conceptualization of the learning environment allows learners to make the transition from learning in a physical space such as the lab or lecture theatre, to learning in a student-centred learning environment in cyberspace. Technology can change the education setting from a physical one to a virtual

one. Virtual spaces may be in constant flux: they can be instantaneous, deliberate, mobile, synchronous and asynchronous. The student's relationship with virtual space can shift rapidly and they may co-exist in several spaces at a time. These virtual spaces can play a bigger role in all aspects of higher education through the use and integration of technology (laptops, handhelds, mobile phones) and communication (wiki, blogs, SMS, podcasting, etc).

The study described here is part of a larger project to investigate the relationship between students and their electronic learning environments, and in particular, how adaptable and adaptive e-learning spaces influence and are influenced by the new student generation learning attitudes, which may well be very different from those of their predecessors (Oblinger, 2003). In particular, it focuses on what we have identified as 'digital students'—the new student generation who have grown up with an everyday use of technology, and who make extensive use of the digital technologies. The final target of the research and also of this study is to build and test an e-learning environment targeted at their needs, based on the assumption of an 'ecology' of learning (Seely Brown and Duguid, 2000) of which our system is only a part.

Adaptive e-learning spaces are characterized by the capability of dynamically customising environment features according to the characteristics of each user or of a user model (Brusilovsky, 2001). The adaptive system dynamically composes a user model from user behaviour. Such a model may be scrutable and adaptable, so that the user is explicitly involved in updating and creating it. The e-learning space on which this study was performed is a hybrid one, containing characteristics from both types of system.

Who are the digital students?

Research methodology

The research method adopted in this research comes from the dialectical version of user-centred design, called *socio-cognitive engineering*, first proposed by Sharples et al (2002) for designing human-centred technology, and used by several others in recent years, especially in learner-centered language learning (Vavoula, 2004; Fallahkhair, Pemberton, and Griffiths, 2005). We adapted the Sharples methodology with a multi-methods approach (Blaxter, Hughes, and Tight, 1998) and we came with the project methodology which is mainly represented by the analysis stage (studies, questionnaires,etc) and design stage (scenarios, prototypes, testing) (Andone, Dron, and Pemberton, 2006). We investigated and tried to understand the digital students characteristics, the theories and technologies used in adaptable and adaptive learning environments which can result in an enhanced learning management system, next to be evaluated. The investigation was comprised of online surveys, focus groups and scenarios. It attempted to identify the unique features of 'digital students'. The exploratory survey's focus was on 'Technology in Education', ran in 2004 in universities from Great Britain, Romania, Hungary, and Finland (Andone, Dron, Boyne, and Pemberton, 2006a). The purpose of the survey was to discover patterns for further investigation rather than to gain statistically valid statistics.

Following the survey and associated interviews, we used scenario-based design methods (Carroll, 2000) to develop a scenario for an e-learning space that we have christened **DIMPLE (Digital Internet and Mobile Phone e-learning Environment)**. DIMPLE was a learning scenario, a description of the progress of the learning situation intended to ensure the appropriation of a precise set of knowledge, formulated a priori as an abstract scenario (Andone, Dron, and Pemberton, 2006b). Two focus groups were run in March 2005 in Romania and UK to gather in-depth, qualitative information, opinions and attitudes about the digital students' characteristics and the proposed DIMPLE scenario. The participants were of different nationalities, both genders, all studying ICT-related subjects, of varying degrees of

ICT competence. The scenario was implemented in several stages (prototypes) and then used and evaluated in real learning environments in UK and Romania. This paper presents the UK study.

Digital student characteristics

The full results of the early studies are presented in (Andone, Boyne, Dron, and Pemberton 2005b; Andone, Dron, Boyne, and Pemberton, 2006a). The main characteristics of the digital student were identified as a result of this research. The characteristics of the technological confident digital students were found to include a strong need for instantaneity, a desire to control their environment and to have a technology based social life (or—to communicate socially by an extensive use of technology).

From our research perspective, 'digital students' are defined as young adult students who have grown up with active participation in technology as an everyday feature of their lives. Among the characteristics that define digital students are that they take the availability of email, instant messaging and text messaging for granted, and use unlimited online resources. The digital world has had a significant impact on their habits and behaviour (Barone, 2003). They tend to use the Internet to search both for educational purposes and for information about their hobbies and interests. They use SMS (mobile text messaging) extensively for contacting their friends and colleagues, as well as IM—instant messaging. These results show that the use of multiple media and technologies is directly connected to their use in education, home and entertainment (Andone, Dron, Boyne, and Pemberton, 2006c).

Treating the Internet and mobile phones as everyday tools means that collaboration is an area of great potential for digital students and they use extensively the "virtual study groups" (Jones and Madden, 2002). These groups can be synchronous or asynchronous but the 'feeling' is of instant communication. This has led to a continuous need for instant feedback which is also found in their learning attitudes. Despite the traditionally restrictive educational settings in which they often have to function, today's students perceive their learning environments as boundless.

Though lagging very slightly behind their UK and Finnish counterparts, the students from Eastern European countries are becoming stronger in their ICT use and understanding and have jumped several technological steps. They started using the computer, the Internet and the mobile phone at around the same time, and after just a few years they are using similar tools (SMS, Instant messaging, search engines, online playing) at much the same level as their Western colleagues (Andone, Dron, Boyne, and Pemberton, 2006a). They use the Internet for research, collaboration with other students, and as a resource for information passed on to them by other students or teachers.

The students' strategic thinking and level of e-literacy may differ from one country to another as the UK and Finnish students declare a more intensive and prolonged use of computers and of electronic games.

They expect to try things rather than hear about them. They want to learn by doing (Tapscott, 1998). They prefer being involved in subject-related activity, problem solving and simulation, so they have an interest in developing real projects and learning by doing, discovering (Papert,1996) or from practice.

The mobile phone is perceived by all the students as a familiar and informal tool. An obvious question then is whether this tool will be accepted by students for educational purposes? Synchronous communication is preferred when students contact one another, while for educational contacts with their teachers the asynchronous model is preferred. As text messaging sits to some extent between synchronous and asynchronous communication, SMS is increasingly becoming the preferred communication tool because of its users' need for

instant response and feedback. Students' ability to select the 'right' communication tool for different purposes also shows their need for control and the development of independent skills.

Students have very specific needs and expectations from their learning environments. They will enjoy enhanced interactivity and connectivity with others, and expect to learn in groups which may be physical or virtual. Students showed some enthusiasm for direct participation and control over certain aspects of the educational process: personalized delivery, the need for instant feedback.

A large number of desirable attributes for e-learning environment emerged from the research, some of them contradictory. For instance, while participants generally want to have 'things coming to them' in a 'rapid, fast way', receiving un-requested learning objects disturbs them. It was clear that no single approach would be likely to satisfy all requirements, and an e-learning environment for digital student will need to use complementary methods and technology and leave the power of choice of the 'right one' to the student.The results were correlated with other research (Beasley, 2004; Dillman, 2000; Eurostat, 2003 , 2004; Livingstone and Bovill, 2001; Oblinger and Oblinger, 2005; Rettie, 2002; Woods, 2002) .

In our attempt to analyse the perceived 'digitalness' of our students and to compare levels of 'digitalness' across several students bodies we have reached several conclusions. The first is that the digital student needs a variety of technologies to choose from, with an emphasis on those that provide a) instantaneity and b) control over the environment. Students want to be able to choose what to do and when and they are demanding it 'now'. Based on the results of this investigation, a prototype e-learning environment, DIMPLE (Digital Internet and Mobile Phone e-learning Environment), was developed and furnished with a number of learning and communication tools, using a dual device interface (online and mobile phone). DIMPLE combines several features of an existing e-learning platform with newly designed adaptable (layout settings, tailored navigation, selection of communication tools), adaptive features (personalised calendar and news), enhanced with new social communication tools (Web2SMS, wiki, blog, video and audio streaming) and by using external resources for communication (instant messaging and VoIP). As a social, adaptable and adaptive e-learning environment, DIMPLE offers students opportunities to receive learning through methods and models that best support their needs, interests, and personal situations, based on the assumption of an 'ecology' of learning.

Using the DIMPLE—the studentcentral environment

To create the new DIMPLE environment (not a single technology but an ecology of complementary technologies) we used features of student**central**, the University of Brighton Blackboard®-centred learning management system, augmented with an Elgg-based blog, wiki and resource-sharing area, combined with instant messaging and voice-over-IP tools. Our main aim was to observe how students use these tools in an institutional educational environment and to evaluate their desirability and effectiveness. In a later study, these results will be examined in conjunction with similar tests done in Romania on a custom-developed DIMPLE environment combining most of these features into a single platform.

Student**central** is a student intranet for the university and has links to the online library, the local student webmail service and many other facilities. In October 2006 the University launched its new Community@brighton area of student**central** which is implemented using Elgg. **Community@brighton** is a social networking and blog service for all students and staff at the University, described by some as an 'online school playground'. Elgg provides a rich authorisation model that allows owner/creators of almost any object on the system, be it a podcast, a whole community, a blog posting or a comment, to control who has access to it. Whether staff or student, every user has the right to create communities that others may join,

which may be moderated or not, and the system is bound together by rich folksonomic navigation tools and tag clouds.

Community@brighton is social software in permanent beta that is constantly evolving. How it will develop depends upon how people use it. It is the users who shape this technology.

The study

This study looked at seven level one computing students attempting a group project for the course *Introduction to Web Design*. We established a course community (blog, wiki and a resource sharing area) on Community@brighton, and students and the tutor shared IDs for MSN and Skype. The Community tools were available for all the 146 students who took part in the course. The communication tools were restricted to the study group (see figure 1).

Figure 1 The CI131 Community Blog

The Community area was very active. The blog proved a popular place for students to ask questions (to which the tutor or other colleagues answered), and to share thoughts and reflections over the course subject and their work in the project. Over 40% of students took part in the blog discussions and 6 other students' established independent blogs for the same subject, restricting access to this community alone. For 3 weeks in late November–early December 2006 the CI131 community (with the blog, wiki and resources area) was among the top five most-used communities on Community@brighton (Figure 2).

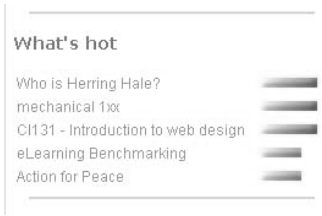

Figure 2 The 'hot'communities in studentcentral in November-December 2006

Findings from the study group

Students perceive email as an 'official thing, for which you contact professors or other people'. As one of the UK students said 'I do not like email as I never know when people read it and when they receive it.' As they all learn in a traditional university with technological support they have also found ways to develop their own supporting network: they contact each other via SMS and IM to get assignments done, to support each other in finding resources (mainly on the Web), to meet face-to-face as well as to get last minute information about timetables, classes or university activities.

The study group used instant messaging and skype extensively to communicate between them and also to communicate with their tutor. When interviewed they reported a 'daily usage' between them and 'when we needed' with their tutor (weekly). The main topics of the chat with the tutor were: issues with software, clarification over the project theme, interesting facts on the course subject. Several times, they shared between them and with the tutor last-minute information about the Internet and Web Design with very interesting and mature reflections. An interesting fact indicative of their habits is that 80% of their communication with the tutor happened after 22:00 hours and very little during office hours. During evaluation, the tutor availability at different hours was considered a strong point of this type of communication. (figure 3)

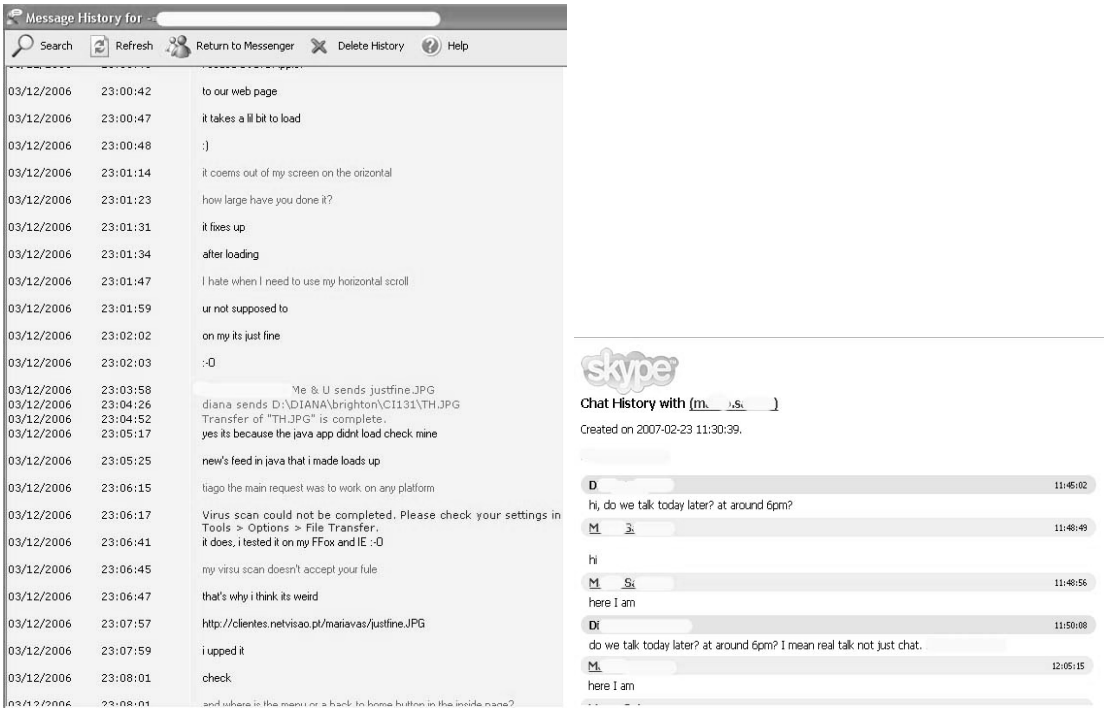

Figure 3 Instant messaging and Skype communication between students and tutor

The students had also access in the Community to a resource file area, which was intended by the tutor to enable uploading and sharing of files for their project. Only three groups of students, each formed of 4 students, (out of 21) used this facility. When asked the reason for not using it, the majority answered that they use the Yahoo briefcase facility with which they are more familiar. Their ability on choosing the familiar and 'right' tool for runing different university assignements is the outside-institution learning environment which they can create, the paralel world in which they learn and work, almost always created independently by the skills or university facilities. It proves again their ability for independent, strategic and 'out-of-the-box' thinking.

UK students' critiques of the university's centrally-managed e-learning environment highlighted several redundant services and 'things which you never use,' pointing again to their strong need of control and independence. They seek control over functionality, not visual aspects: a typical comment was 'I want tools as IM and SMS and to see when my colleagues are online, to choose the length of text of a course, to have interactive activities, less interested to change colours more interested to change the text size and the links.' These comments came more from the students who used the technology daily to gather information, access studentcentral and Community and used different communication tools.

As a general perception the proposed DIMPLE –studentcentral environment was considered 'very useful' and its learning functionality 'is going to be efficient, you are not duplicating information it is all linked.' In the interviews, opinions about identification with the digital student were frequently expressed: 'I'm like this. I think everybody will like this. I do this all the time.' An adaptable learning environment was seen as very desirable: 'it's good to have it personalised', 'it's good to see when you are online' and collaborative environments are attractive 'if I find something useful I will like to share it with my colleagues'.

Our results suggest that digital students' need to control their online and e-learning environment is directly associated with their high use of technology.

Evaluation

We studied the impact of the various features on the experience of the new student generation. The environment was used in normal University course by groups of both "digital" and "non-digital" students. The usage made of the environment was measured, and qualitative evaluation (interviews) was carried out to establish attitudes and preferences, as presented previously. We also evaluated the environment for its desirability to the study group of students (digital and non-digital). To evaluate the desirability we used a usability methodology developed by the Microsoft Usability Lab (Benedek, 2002) focussing on the 'product reaction cards' method. We developed a large set of word cards that formed the basis for a sorting exercise and more importantly a discussion about the use of the environment. Since there is a bias to give positive feedback in the university relations already established, we made sure that at least 40% of the set consisted of negative words and phrases and tried to make the set cover a wide variety of dimensions. Each word was placed on a separate card and the set was given to the students at the end of the course module.

On the first round each of the students was asked to pick the words that best describe their "experience in using the studentcentral, the community area, the blog, and the Instant Message and Skype with your tutor". The results are shown in figure 4.

The words selected by all the students were: 'accessible' and 'useful', while all but one selected 'fast'.

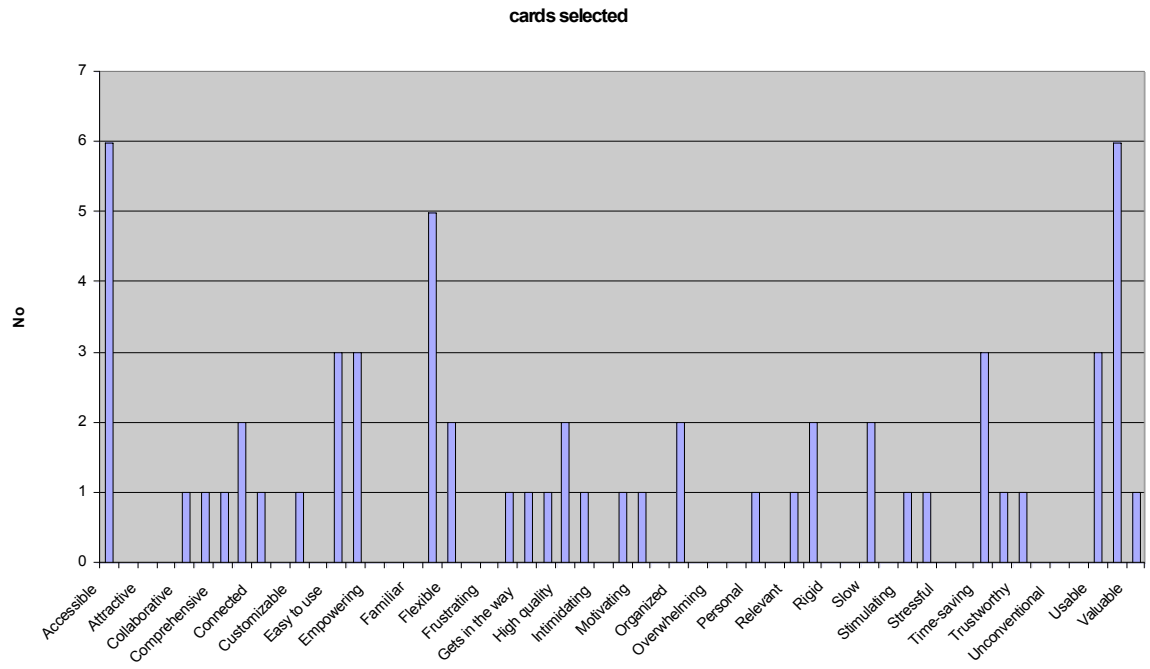

Figure 4 Words selected in the first round of the desirability test

The next test asked them to select five words which best described their experience of using all the components of DIMPLE with their tutor, then to rank them on a scale of one to five (one being the best word to describe the experience and five being the least). The results are presented in tag clouds in figure 5. The italics mark the words which were most often used negatively, as those least appropriate to describe the tools:

Accessible Desirable Gets in the way Patronizing Stressful

Appealing Easy to use Hard to use Personal Time-consuming

Attractive Efficient High quality Predictable Time-saving

Busy Empowering Inconsistent Relevant Too technical

Collaborative Exciting Intimidating *Reliable* Trustworthy

Complex Familiar Inviting Rigid Uncontrollable

Comprehensive Fast Motivating Simplistic Unconventional

Confusing Flexible Not valuable *Slow* Unpredictable

Connected Fresh *Organized* Sophisticated Usable

Consistent Frustrating Overbearing Stimulating Useful Customizable Fun

Overwhelming Straight Forward Valuable

Figure 5 The words selected most to describe the general experience

Using the same method we asked them to repeat the exercise for only the Community@Brighton area. The results were somewhat different from their general experience. “Accessible” and “appealing” moved from a positive to a negative experience (figure 6).

Figure 6 The words selected most to describe the Community experience

The last test asked the students to repeat the exercise for Skype and MSN. Only four students fully answered and wanted to participate. The other three out of seven had contacted the tutor using these methods only once and they didn’t considerd their experience relevant enough for a pertinent answer. Their selections were limited to a smaller number of words than for the other two instances, which may be partially explained by the smaller sample (figure 7).

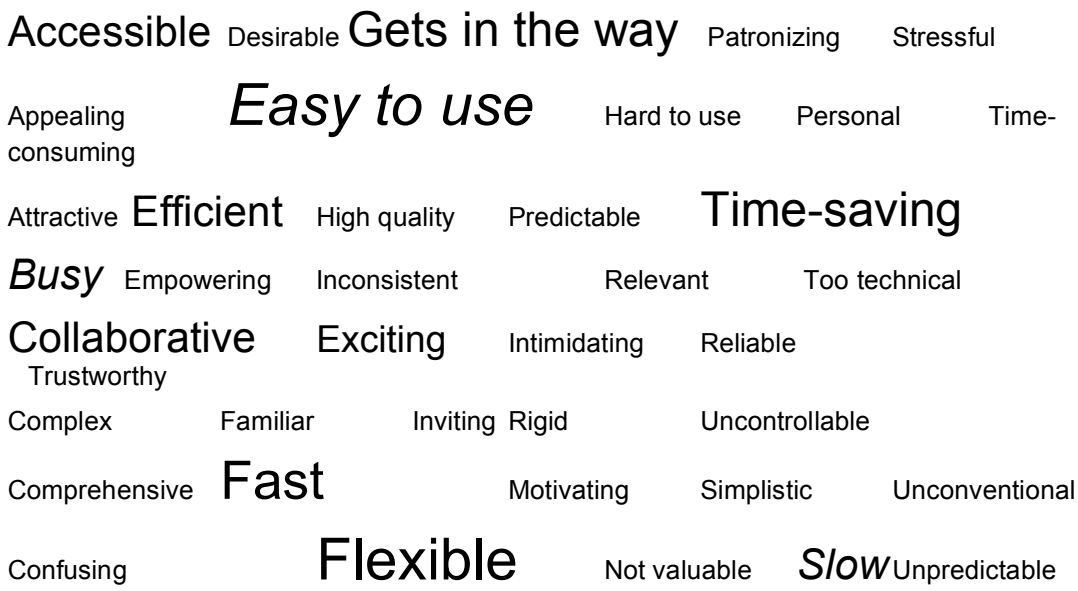

Figure 7 The words selected most to describe the use of IM and Skype experience

It appears from this that the instant messaging tools were considered far from easy to use, yet was overwhelmingly thought to be useful.

Conclusions

In this study we tried to investigate the use of a DIMPLE environment by digital students. We must express that the study had a small sample 2 groups of 4 students out of the 175 students of that course module, they were students in ICT area and that they used a simple version of DIMPLE (the adaptive features were not present as the University of Brighton **student**central didn't allowed these changes). For testing we used different methods: questionnaire, interview and the desirability test. All of them gave the results presented in this paper.

The results indicate that an e-learning environment which has the described tools and involves student control leads to greater engagement in the learning process and a higher level of satisfaction of the group which we identified as digital students.

The study results played a key role in directing our e-learning environment development strategy and have influenced some major decisions. One such decision concerned the appropriateness of formal learning structures for Internet and Mobile phone based services. A further development of DIMPLE included Mobile phone based services (SMS, calendar) which were desired also by the students of this study.

As our interest is in broad trends, we believe that technology integrated with methods for communicating knowledge can enhance and stimulate learning. However, we should express a note of caution: it is at least possible that learners' preferences may be for modes of learning that are ineffective and counter-productive. The trend away from predominantly analytic knowledge towards primarily synthetic knowledge implies a loss as well as a gain (Seely Brown, 2000). We are currently evaluating a new developed DIMPLE environment which was used over a whole academic semester in a Romanian University to explore whether giving digital students what they want will also give them the rich learning experience that they need. By providing an alternative based on a profile of digital students' interests, we hope to enable uses of technology that provide a better fit to their needs, and a means to break out of habitual behaviours that may not always be the most effective means of learning available to them.

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PAPER 1077

Investigating university students' prior experiences of technology and their expectations of using technology in their studies

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Abstract

Who are the university students of the 21st Century and what characteristics do they have in terms of their interest in using technology for learning? They have been called, for instance, 'the iPOD generation' from the high number of sales to this age group of one of the technology icons of the early 21st century. Another nickname is 'The Net generation' from the apparent ease with which students use the internet to support their leisure, study and lifestyles and apparently move seamlessly from one medium to another.

This paper presents the findings from an investigation into prior experiences of technology use in the study and leisure activities of students at the start of their university careers, at a popular post-1992 university with a strong track record for providing high quality technology for learning. The investigation also considered the students' expectations of using technology in their studies and the perceived barriers which students anticipated in using technology for studying. An initial enquiry was carried out via an online survey and a later extension to the study used a paper based questionnaire format to deliver the same questions to students in a lecture room. Students were invited to take part in a series of focus groups to determine how far the initial responses and results were confirmed by their spoken opinions. Over 600 students starting at university took part in the initial survey and the participants came from a cross section of the university's faculties and departments, including students who have traditionally embraced technology and those who are typically less keen to use technology.

Introduction

In 'Harnessing Technology' (Kelly, 2005) the UK Secretary of State for Education, Ruth Kelly introduced a strategy for promoting e-learning and referred to the importance of encouraging the use of ICT and e-learning for all schoolchildren and students. This built upon the impact of the earlier Dearing report (Dearing, 1997) which had called for the effective use of information technology in learning and teaching in Higher Education, suggesting that it,

> *'… holds out much promise for improving the quality, flexibility and effectiveness of higher education'.*

For many secondary school students this latest encouragement for ICT use has already arrived, recent years have seen the increased use of accessible technologies such as interactive whiteboards and computers in their classrooms and news reports propose internet access from home for school children (BBC News website, 2007). It has been claimed that many new university students have typically grown up with easy access to a diverse range of technologies in their leisure and study, for example by Demos (Green and Haddon, 2007) in 'Their Space-Education for a digital generation'. Students often appear relaxed about accessing their music off the web and in using a variety of technologies in their everyday lives.

Marc Prensky in a recent paper (Prensky, 2001) coined the phrase, 'digital native' to describe the members of a generation who have access to all things digital and use technology without a second thought. While one might debate the frequency of use and availability of technology, it is not in dispute that the current generation of new students has a greater potential to access and use digital technology for learning and leisure than in any previous age. These students represent the first generation to grow up with technology becoming a ubiquitous part of their lives whether at home or in class. As this generation moves into adulthood and university study, this paper seeks to enquire about their expectations of using technology in their higher education studies and how far these expectations are accommodated within the varied learning environments of higher education?

While considering the attitudes of a generation of possible 'digital learners' however, a warning needs to be sounded. Are academics in danger of applying this stereotype of a generation at ease with technology to all students entering HE? Could this in fact lead to the alienation of others who are unfamiliar with ICT or unwilling to use it, who might be left further behind their peers if there is a failure to provide the necessary technical and training support? A significant number of those embarking on university study in the UK are classified as 'mature students' i.e. over the age of 21 on enrolment. This paper accordingly compares the expectations of students entering HE irrespective of age.

Aims of the study

This study set out to investigate which technologies students had already encountered in studying, working and leisure in the year prior to enrolling at university and the frequency with which these were used and their expectations of using technology while living and studying in a university environment alongside their preferences for using technology in their studies. Finally the authors considered whether in the students' opinion technology could enhance the learning experience.

Methodology

In October 2005, the authors developed an online survey for all new first year undergraduate students at the University of Hertfordshire, administered through an external survey provider. The survey was made available online for 4 weeks to cover the period of students arriving and settling down at university and to give them time to find their way onto the MLE (Managed Learning Environment). An invitation was placed on the students' personalised portals encouraging all new students to take part, with a prize draw to encourage their involvement. An email message was later sent to all first year students via the MLE, which at Hertfordshire is known as StudyNet inviting them to participate.

While any student could choose to participate via the online link, all those from other years were later removed by a comparison of the student ID numbers with enrolment information. Of an initial 815 who completed the survey, this was cleaned up to a participation number of

602, once duplicates and those from other years had been removed. Statistical analysis of the results followed. Approximately 9 % of the first year undergraduate intake participated in the online survey.

In February 2006 a paper based study based on the original questionnaire was developed with the aim of inviting participation from those students who had chosen not to complete the original survey. The aim of this was to target those students who might not in fact, be technically at ease with the internet. The questionnaire was completed, at the end of a lecture, by groups of first year undergraduate students from four faculties across the University: Engineering and Information Sciences (EIS); Health and Human Sciences (HHS); Law and Humanities. These faculties were chosen to represent laboratory, practice and library-based disciplines and covered both natural and human science subjects; thus including those who are traditionally at ease with using technology (e.g. Computer Science) and those who may be less at ease using technology for learning (e.g. Nursing and Humanities). These surveys were then followed up with an invitation to join a series of informal focus groups. The focus groups were designed to provide additional information to the research team on the students' attitudes and expectations. A total of 126 students completed the paper based survey, with a slightly higher proportion of students from the health care departments than in the original on line survey. Subsequently 20 students from the Computer Science, Biology, Nursing and Education departments took part in the focus groups conducted by a research assistant.

Building a profile of the incoming student population

Age and gender spread and activity prior to enrolling at university

Figure 1 shows the age and gender spread of the participants (n= 602) in the online survey. 73.2% of the overall respondents (almost equally male and female) were aged between 18 and 21.This is similar to the university's overall profile of its new intake of students. The results show that for most age groups there are no major gender differences but with the 18–21 group, where there were significantly more females (55.3%) than males (44.7%). This reflects the UK national profile of 56% women entering HE. The numbers of 'mature' students i.e. those aged 22 or over on registration reflects the overall profile of the university's intake. The majority of the largest age group (18–21) were studying in the previous year (81.2%) rather than working (14.5%), family commitments, travelling or other (4.3%). This pattern was matched by the 22–25 age group. For the other age groups there was a greater mixture in the activities that they were performing, but the modal activity was working.

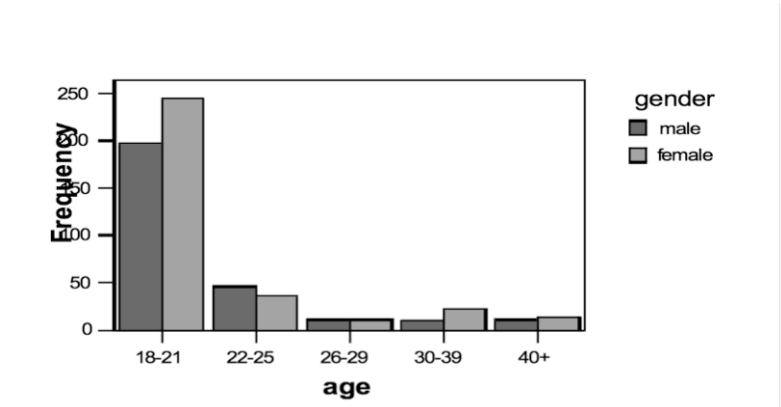

Figure 1 Age and gender of new students

Access to technology prior to starting university

Students were asked to identify the technologies they had been using in the previous year and where they would access these from. They were presented with the following list of technologies: email, text messaging via mobile phones, internet for leisure and learning, and wikis, blogs and interactive whiteboards. The aim of this question was to determine whether their use was confined to the more familiar technologies or whether they had been introduced to the use of media such as blogs, and wikis. Students responded on the frequency of their use of technologies. The research team had discussed at length with colleagues at the time (September 2005) how many and which technologies to include, trying to balancing the need for a relatively concise survey and the then current and expected use of technologies in HE. Social networks, such as Facebook, were in their infancy in the UK at the time and so were not included.

The 18–21 age group, the largest single group of students, were using the following types of technology on a daily basis: email (71.9%), text messaging (72%) and surfing the internet either for leisure (34.6%) or for learning (46.6%). Overall for all age groups, over 75% of the students were using email and 82% using text messaging from their mobile phone on a daily basis. The proportions for use on a minimum of a weekly basis were even higher.

Confirming the authors' hypothesis that the new intake of students were indeed willing and at ease using technology, 90% overall answered in the columns for 'very much' and 'moderate' when asked 'How much would you like to use technology in your studies?' It would therefore appear clear they are as a new cohort generally comfortable with using technology and keen to make use of it in their studies.

As far as weekly technology use in the last year there was no substantial difference reported between the genders and their technology use. The only difference worth reporting was of computer games which were used twice as many times more per week by males (21.9%) than by females (10.2%). The authors were surprised at the relatively low number of overall users of internet computer games, which seemed at odds with current perceptions that this is a very important leisure pursuit. However this could be explained by the difference between the 'play station' type games which are played solo or synchronously with friends, while internet based games are more likely to be asynchronous and require a high level of competence with technology. Other than the first four popular technologies (email, text messaging and surfing the internet for learning and leisure), weekly uses of other types of technology especially those related to teaching and learning were generally less than 10%. This would imply that use of interactive whiteboards has not in fact been prominent for the current intake of students, nor had many of them used blogs or wikis prior to October 2005.

Current access to technology

The university's policy is to offer accommodation to all first year undergraduates and overseas students. This cohort of first year students therefore had the option to apply for accommodation on campus or to live at home or rent accommodation privately. Internet access is available from most university hall of residence rooms as well as being freely available in the open study areas. When asked if they had access to the internet from their term time home 90% claimed to be able to access the internet from their home either on or off campus. The students least likely to be based on campus are the mature students (26.7%) but it is clear from these figures that there was still a high proportion of the mature students who were able to access the internet from their home base. Overall responses to the question which asked whether students had easy access to a computer were 97.7% and to the internet, 94%. When the same question was asked of the students completing the paper-based survey the figures were similarly high with over 90% having easy access to a computer and the internet. Concern over students' ability to access technology had been one

of the principal issues raised by academics in a previous study which considered academic attitudes to the increasing use of technology in universities (Thornton et al., 2004) and also *inter alia,* Bowl (2003) Being able to access their study materials off campus via the university's managed learning environment was valued as one of the chief advantages that technology brought to learning. The ease of electronic communications was valued by nearly 80% of students as a means of supporting their learning. This finding has also been reported by Sharpe, Benfield and Roberts in their recent review of the undergraduate experience of blended learning.

> *'We find that student response is overwhelmingly positive to the provision of online course information to supplement traditional teaching. Students make regular and frequent use of electronic resources with few reported problems of access.'*
> *(Sharpe et al., 2006)*

Students' perceptions of their confidence in using technology

When asked about their confidence at using technology, levels overall were high in the online survey group with 74% being 'very' or 'extremely confident' about using technology in the context of studying and just under 3% who claimed to be not at all confident. Of this less confident 3%, most (87.5%) were female and from the 18–21 age group. Fewer older students both male and female (i.e. those over 25) reported high levels of 'extreme confidence'. This would suggest that the stereotype of older students reporting generally less confidence compared with younger students may be true. This result is of interest because nearly half of the older students reported that they would like to use technology during their course. Confidence and a willingness to use technology may not therefore be in complete alignment. When a chi^2 was carried out it showed that there was a significant difference between age and confidence, and also gender and confidence which supports the above findings. This becomes more apparent in the results from the paper-based survey where 33% of the women aged 30–39 claimed to be 'not at all confident'.

A chi^2 test was conducted on the results of the paper based survey to examine the relationship between age and confidence levels in using technology. The test found that there was a significant relationship between age and confidence levels: $x^2 = 20.3$, $p<0.001$. Cramer's V value shows that 16% of the variation in frequency counts of confidence can be explained by age. Another chi^2 test was conducted to examine the relationship between gender and confidence levels. This also resulted in a significant relationship: $x^2 = 28.142$, $p<0.001$. Cramer's V value shows that 23% of the variation in frequency counts can be explained by gender. When asked if they wanted to use technology in their studies the older students generally expressed at least an equal desire to use technology in their courses as younger students. Figures are given on an age by age basis in Table 1. Those wanting to use technology 'very much' were 43.8% and those wanting to use it 'moderately' were 46.2%. As mentioned above together these add up to a total of 90% of incoming students across all faculties with a positive attitude to using technology in their learning.

	Very much		Moderate		A little		None at all		Don't know	
Age	No.	%	No.	%	No.	%	No.	%	No.	%
18–21	177	31.9	190	34.3	37	6.7	3	0.5	3	0.5
22–25	37	6.7	29	5.2	3	0.5	0	0.0	2	0.4
26–29	8	1.4	8	1.4	3	0.5	0	0.0	0	0.0
30–39	10	1.8	17	3.1	3	0.5	0	0.0	0	0.0
40+	11	2.0	12	2.2	1	0.2	0	0.0	0	0.0
Total	243	43.8%	256	46.2%	47	8.4%	3	0.5%	5	0.9%

Table 1 Percentages of students according to age wanting to use technology during their course from the online survey

Student preferences for the use of technology in supporting the classroom experience

Many universities now permit students to access study materials and other information via an MLE or VLE. It was of great interest to the authors to determine how campus-based students approached their learning when offered the complete MLE experience with online access 24/7 to their study materials. This has been described as a 'blended approach' to learning:

> *'the thoughtful integration of classroom face-to-face learning experiences with online learning experiences' (Garrison and Kanuka, 2004)*

as it provides a blend of materials delivered in the traditional 'face to face' classroom environment alongside electronic access to carefully designed online materials and online environments which may include virtual groups and discussion forums.

In the online survey the students were asked to rate in order of their personal preference a variety of teaching and learning options. These ranged from all 'face to face' to all 'computer based'. The results are shown in Table 2. In examining the results there was little overall preference for *first choice* among the students between:

- 'Only face-to-face' (33.1%)
- 'More face-to-face than computer based' (33.8%)
- A 'balance of computer and face-to-face' (29.9%)

But when the authors considered those highly rated for "2nd" and "3rd" place, the highest for 2nd is 'more face to face' (50%) and the highest for 3rd place is a 'balance of computer and face-to-face' (43.9%). This was difficult to interpret as there did not seem to be a preference for 1st place from the first 3 learning techniques which contain face-to-face, but when looking at the 2nd and 3rd place, it became apparent what type of learning techniques students would prefer: the less face-to-face and more computer based it becomes, the less highly it is rated:

- 'more computer based than face-to-face' 68.8% for 4th, and
- 'only computer based' 89.6% for 5th preference.

Students appear to be showing a clear preference for choosing a campus based experience which combines elements of online access and computer based learning. In other words they came to university to participate in a 'face to face ' learning experience but supported by the

technology to access materials when and where they wanted. This point has also been addressed by Barrett (Barrett and Jefferies, 2005). These results provide an interesting comparison with those reported by Roberts in Chapter 3 of 'Educating the Net Generation' (Oblinger and Oblinger, 2006) from a set of focus groups which he conducted into student preferences for e-learning. Here all of the 25 students involved stated their preference for a 50–50 mix of traditional lectures with online interactive material for their HE learning.

	1st %	2nd %	3rd %	4th %	5th %
Only face to face	33.1	18.9	20.7	19.4	7.9
More face to face	33.8	50.0	11.7	3.8	0.7
Balance between F2F and computer based	29.9	23.9	43.9	1.6	0.7
More computer based	2.2	6.7	21.2	68.9	1.1
Only computer based	1.1	0.5	2.5	6.3	89.6

Table 2 Percentage of student preferences for different learning techniques

Anticipated barriers to using technology in learning

Students were invited to give their opinions about the disadvantages of using technology to enhance learning. There was a general mistrust of the reliability of *access* to technology by students with nearly 50% stating that problems with accessibility could be a disadvantage to using technology to enhance learning. Their primary concerns as recorded by 73.8% concerned the general reliability of technology i.e. 'systems going down'. It is the authors' experience from a study with final year students that the university's StudyNet is generally perceived to be very robust and reliable (Thornton et al., 2004, Jefferies et al., 2005). Interestingly these barriers are identified by a group of students who in general do not appear to have accessibility problems and in a situation where most of them had only just started using the university's own e-learning environment. Cost, which has been suggested in the past as a major inhibitor of taking up technology was only recorded as a potential barrier by 27.2% of students.

Students' perceptions of the advantages to using technology to support learning

The students' own perceptions of the advantages of using technology to support learning show much enthusiasm and provide encouragement for academics keen to use technology in teaching and learning. The option to access their learning electronically via the MLE was important to the students and reflects the findings of Sharpe (Sharpe et al., 2006). 82.9% identified access to learning while *off-campus* as the main advantage of using technology to enhance learning. Another highly rated advantage was that technology provided easier methods of communication (74.9%), while two thirds of the students anticipate that an advantage of using technology in accessing learning is the *variety* of learning styles and techniques that are available. Other perceived advantages of using technology to enhance learning were: improving their use of IT skills, learning at their own pace and managing time more effectively. The impression is one of greater confidence in using ICT and optimism that

accessing learning through the technology of an MLE will provide many benefits. Table 3 summarises students' ratings of the advantages of using technology to support learning.

Perceived Advantages	Percentage
Access to learning facilities when off campus	82.9
Easier methods of communication	74.9
Improve use of IT skills	66.9
Learn at your own pace	64.8
Variety of learning styles/ techniques	61.1
More independence	59.3
Manage time more effectively	51.2

Table 3 The perceived advantages for students in using technology for learning (online survey), (n=602)

Differences recorded between the online survey and the paper based survey

On most occasions the answers recorded by the students from the paper-based survey were inline with those who answered the online survey. Figures for accessibility to computers and the internet and for overall willingness to use technology were very similar. The main difference was regarding confidence levels with some mature students who were noticeably less confident at the prospect of using technology in their studies while still being willing to use it. However, while the students responding to the paper based survey recorded similar levels for their perceptions of the disadvantages of using technology for learning they recorded much higher levels of perceived advantages at using technology for learning with a different order from the reasons given by the online survey results. Table 4 shows the results for the paper-based survey.

Perceived Advantages	Percentage
Improve use of IT skills	95.2
Easier methods of communication	94.4
Access to learning facilities when off campus	93.7
Manage time more effectively	90
Learn at your own pace	88.9
More independence	88.1
Variety of learning styles	85.7

Table 4 The perceived advantages in using technology for learning (paper-based survey) (n=126)

These results could indicate a clear enthusiasm for using technology in learning (with a high score for easier methods of communication and access to learning facilities off-campus) and a more definitely held view that it would improve their existing skills. In fact there is very little separating the top 6 preferences but it is worth noting that students in the paper based survey appear to have a very high appreciation of the advantages of using technology for learning.

Comments from the focus groups

Students were asked to comment on some of the issues that had arisen from the results of the surveys. This was a useful exercise which showed that student opinions broadly supported the findings from the surveys.

In terms of the advantages of using technology, most were enthusiastic about using materials placed on the MLE:

> *'For whatever reason if you can't be in a lecture…you know that the slides are on the Internet.' (BSc Computer Science)*

But some were less keen users:

> *'You can't get to know the lecturers because there is too much technology and not enough interaction.*
>
> *Technology is a communication barrier.' (Nursing)*

Off campus accessibility meant that it was easier for student to choose where they wanted to work and some expressed a preference for not having to travel in to the university:

> *'It's fine studying at home… you can access StudyNet…, and that makes it easy you know, you don't feel tired coming from home to here (Univ) just for using the net.*

(Biology)

> *'It is convenient to work from home but the LRC (Learning Resources Centre) is always there.' (Nursing)*

These reiterate the need to find a balance in the design of the blend of technology use and teaching materials used.

Discussion and conclusions

A number of conclusions can be drawn from this major study into the prior experiences and current expectations of students embarking on their higher education career. The majority of students appear to be at ease with using technology to an extent that may take their tutors by surprise and which may be beyond the means of some academic staff to match (Sharpe et al., 2006). This point has also been raised by Oblinger following research conducted with the same age group in the U.S. (Oblinger and Oblinger, 2006) and has been taken up recently by Demos in their paper 'Their Space' (2007). This trend to easy familiarity with multiple types of technology (PC, mobile phone, digital camera and iPod) is generally expected to grow as incoming generations of students experience a 'connected world' in their prior education and experience. The growth in the use of the internet for 'social networking' sites in the past eighteen months evidences this with, for example, realistic claims that MySpace has over 43 million users (source forevergeek.com/articles, May 2007). However the focus of this study was primarily on the use of technologies which support learning rather than socializing.

While the vast majority claims to have easy access to a computer and to the internet, there is nevertheless a small minority of students entering HE who lack confidence and do not have access to either a computer or the internet and do not fit the stereotype of being young and keen to use technology. Older (and some younger) women entering the HE environment are

significantly less likely to report that they are confident in using technology. It is therefore suggested that university tutors should consider the demographics of their cohorts and the provision of targeted support such as personal mentoring for those lacking confidence in using technology.

Students are definitely enthusiastic about the opportunity to have their materials available online for accessing any time, but the main reason they have opted for a campus based university course is for the opportunity for face-to-face teaching alongside access to technology, i.e. 'a blended learning solution'. Can they trust the technology to deliver their expectations? The student reactions reported in this study show that they were initially sceptical about the reliability of a central system, in spite of the reputation of this university's MLE for robustness. The reported barriers to learning from technology were in most students' views easily surpassed by the advantages that they perceived in using technology to support their learning. Respondents to the paper based survey which had recorded more reluctant (and less confident) users of technology demonstrated that students had a high opinion of the potential advantages of technology for supporting learning.

The purpose of this survey was to identify a baseline against which to measure both current and future students' experiences and expectations of using learning technologies. A further study is being considered with the same cohort of students as they graduate, to explore the extent that their confidence with learning technologies has increased and extended into use of available Web 2.0 technologies. Reported prior use by students of wikis and blogs in October 2005 was extremely limited. It is expected that 2 or 3 years later the results would be quite different.

In summary, a large majority of these students expected to use technology to support their learning and had high expectations of its use across their courses. Accessibility to a computer or the internet is not a problem for over 90% of this group, although some considered poor access opportunities a potential disadvantage. The students' enthusiasm for using technology to support their learning is tempered by their preference for a balance of face to face teaching to match the online materials. While students perceived that the unreliability of systems may be the main disadvantage in their use to start with, there was no later evidence that this is so.

The authors would definitely agree with the need to ensure that the presence or absence of technology does not drive the students' learning but rather the other way round, since as Salmon has said in the context of recent discussions on pedagogy and e-learning:

> 'No VLE will ever be enough in itself to create great e-learning. ' *(Salmon, 2005)*

In terms of lessons to learn now for designing the future learning for our students, emphasis needs to be placed on ensuring that university teachers are themselves confident and enthusiastic adopters of technology to support pedagogy so that they can provide the best possible teaching and learning experience for their students whatever blend they choose.

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