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Building for the Future of Educational Telematics: Models, Foundations and Frameworks*

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Distance educators are relying increasingly upon telematic solutions to connect with remote students. The authors argue that educators should have a sound knowledge of the pedagogical applications of telematic technology and how it impacts upon the distance learner. This paper uses a construction analogy to outline the basic building blocks of telematic learning delivery, and examines three key areas of implementation: theoretical frameworks, integrative approaches, and benefits analysis. Current practice and research into distributed learning networks in rural South-West England are described and a range of telematic technologies are examined. The paper offers benefits analysis and evaluation of the effectiveness of these applications to different learning and teaching contexts.

INTRODUCTION

AS A PART of the social programme of the 1998 international On-line Educa Conference held in Berlin, Germany, delegates were invited to tour the Potsdamerplatz building development in the centre of the city. Potzdamerplatz is currently the largest construction site in Europe. Conference delegates were shown how the German government is building for its future by investing in the creation of an infrastructure that will be enjoyed by many generations to come. The infrastructure is at the same time boldly futuristic yet practically multi-functional, comprising not only the buildings, but state-of-the-art communications systems, fuel and electricity lines and other essential utilities. Visitors to Potsdamerplatz will note that the construction companies have excavated deeply to create good foundations to support the building work. The Info-Box, a distinctive red building on stilts situated in the centre of the construction site, affords visitors access to architectural plans, three-dimensional models and virtual reality tours of the new city centre in its soon-to-be-completed form. This restructuring and renewal is taking place as a result of the reunification of East and West Germany—a new age birthing a new city.

In many ways, distance educators are in a similar position to the construction companies in Berlin. A new age—the digital age—has already been with us for some time, with a bewildering array of technologies available to the distance educator. On the face of it, the changes and rapid speed of development are like shifting sands—not a very promising foundation on which to build. In order to exploit these rapid technological changes without being swept along by them, those involved in the practice and management of distributed learning strategy must dig down deep in order to build upwards. This excavation includes exercises in exploration, thinking, planning, model making and foundation laying before effective distance learning opportunities can be offered and new technologies exploited to their fullest. This paper outlines the basic building blocks of distance education—the models and frameworks currently being developed and adopted by the University of Plymouth and other UK universities in order to plan and rationalise its distance learning strategy.

THE UNIVERSITY OF PLYMOUTH AND TELEMATICS

The University of Plymouth is a regional university, located in the south-west peninsula of England and spread across almost 200 kilometres of predominately rural area. It has a growing number of 'outreach' learning centres and campuses, many of which are situated in very remote areas that are relatively inaccessible (Fig. 1). These are linked by telematic solutions including videoconference, digital satellite television and data transmission and Internet connectivity. Telematics can best be described as the convergent action of telecommunications (networks and telephony) and computers [1].

Travelling between sites is often problematic due to the poor travel infrastructure and other factors such as the seasonal tourist influx that creates

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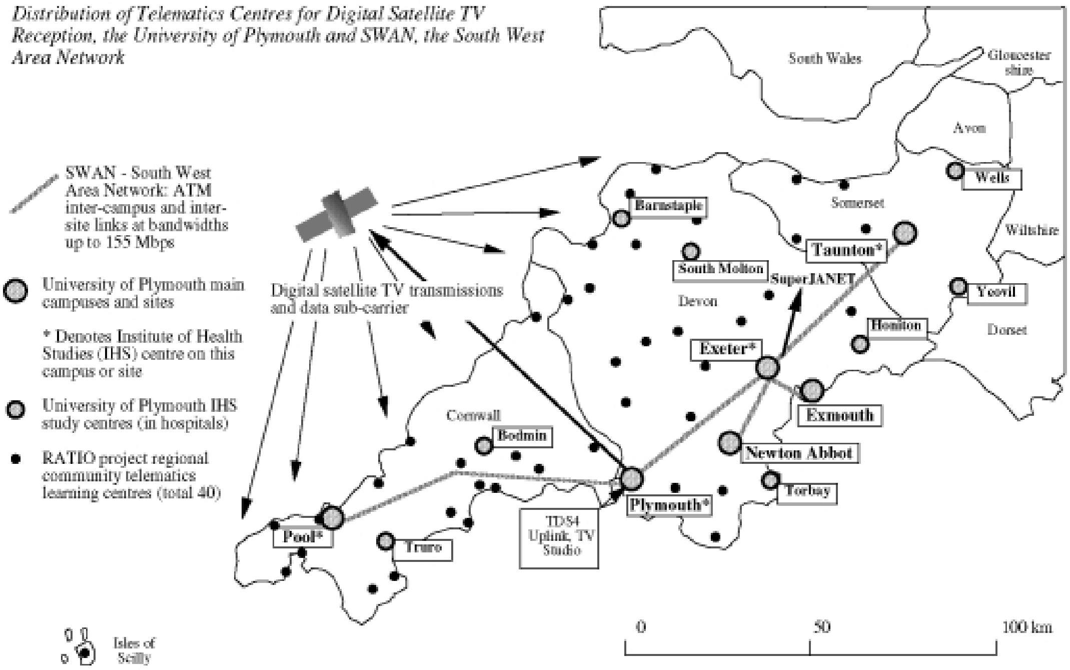

Fig. 1. The University of Plymouth telematic infrastructure.

congestion on narrow country roads during the summer months. Dispersed student populations and increasing staff travel and subsistence costs encouraged the university to seek alternative methods of learning delivery. Distributed modes of education, and in particular, distance learning methodologies were the obvious choice, as they addressed many of the problems identified. Over a period of time the university began to rationalise its approach.

Rationalisation process

The first stage in the process of rationalisation was to identify the range of methods, modes and media currently available for the development, delivery and support of distance learning activities. To do this, the 'Martini' model of education ('anytime anyplace') was re-developed and applied. This model has been variously presented by Johansen [2], Looms [3] and Pohjonen [4]. The model was recently contextualised by

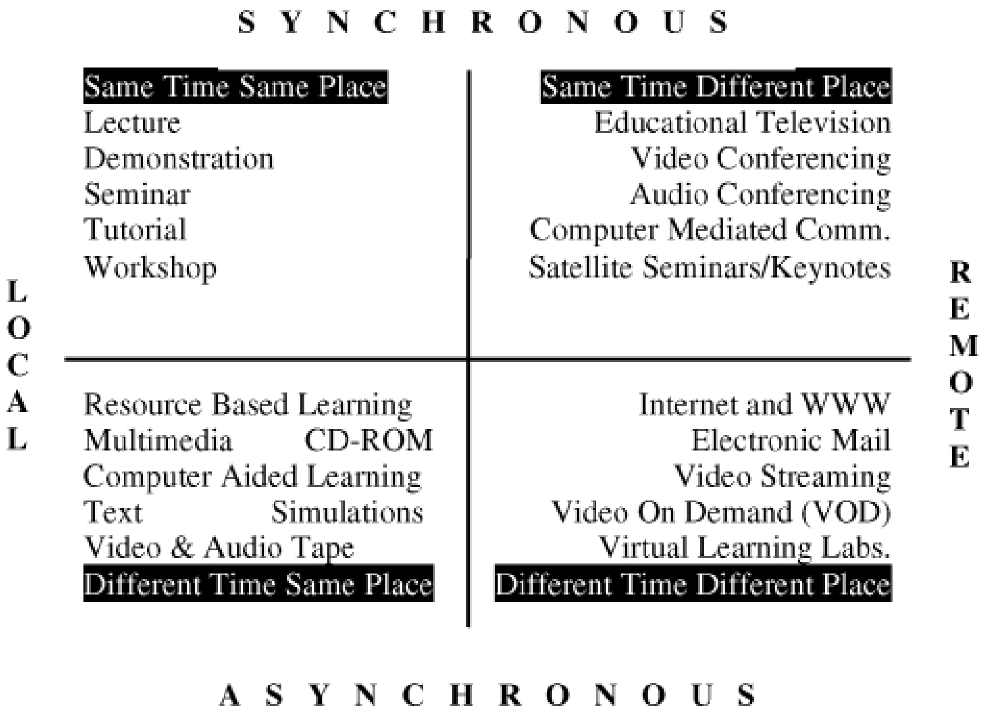

Fig. 2. The University of Plymouth 'any time, any place' model of education.

Vanbuel [5] and the most recent iteration, with modifications by the authors, is presented in Fig. 2.

To be applied effectively, a model of this nature requires some qualification. The first quadrant in Fig. 2 (synchronous/local) can be referred to as a traditional, or 'real-time encounter' mode, as it relies on face-to-face contact between teachers and students. This is still the most prevalent model for the delivery of education and training in most countries. The second quadrant (synchronous/remote) is known as the simultaneously distributed learning model. It relies on the teacher and student being present in the same time frame, although separated by distance. The third quadrant (asynchronous/local) is often referred to as the independent study model, and is exemplified in many higher education institutes as self-directed study or resource based learning. The final quadrant, (asynchronous/remote) is a truly time independent model, where student and tutor are separated by both geographical distance and time frame. This quadrant features the most extensive technological support, and also depends heavily upon highly motivated students for its success rate. A distinction can therefore be made about geographical and temporal differentials, and appropriate technology solutions applied to create connections between tutor and student and between student and student. It should be noted that some of the identified technologies are applicable to more than one quadrant, depending upon the context and application.

Transactional distance

In this model it is important to recognise that although the geographical and temporal distances can be adequately bridged by technology, there is also a psychological distance, sometimes referred to as 'transactional distance' [6] or 'instructional gap' [7]. Moore [6] has suggested that lack of dialogue due to rigidity of course structure will be responsible for an increase in the psychological distance between student and teacher. This potential 'fall zone' can only be bridged by the sensitive social and pedagogical skills of professional teachers. If it is not effectively bridged, this differential may result in mismatches between what the course author desires to communicate and the students' interpretations [8], and between the intentions of tutors and the expectations of students [6]. Ultimately, transactional distance may result in undesirable consequences such as confusion, frustration, demotivation and increased student attrition rates.

Recent studies by the authors have identified something of the nature of this gap, revealing that several discrete forms of dialogue-based learner support are expected by both remote and local students. These include social support, technical help, feedback and direct instruction. Also indicated in the study is the notion that remote students expect and receive a great deal more of this learning support than local students. Nevertheless they still receive less than they expect, indicating that remote students expect distance learning to be both a qualitatively different, and potentially problematic experience [9].

PATTERNS OF COMMUNICATION IN TEACHING AND LEARNING

Many of the features of traditionally based teaching and learning can be duplicated and even improved via telematic methods. Indeed, there is a great deal of evidence to support the argument that distance education is every bit as effective as the more traditional classroom-based approach [10, 11]. Notwithstanding, learning at a distance is fundamentally different to learning in a classroom [12] and the most significant difference is in the area of dialogue. Patterns of communication between teacher and student, and between student and student, are of course put under tension when participants are separated by geographical and temporal distance.

According to Collis there are four patterns of communication apparent within the learning environment [13]. These are:

- *Telling*—traditionally, instruction has been achieved by lecture and printed text. This delivery method is essentially didactic, and one-way in nature. In telematic delivery, instructive activities can be achieved via a range of technologies, including web delivery and satellite television. In its purest form, 'telling' need not be synchronous to be effective—students can access information at a time that suits them, without the lecturer necessarily being there at the same time.
- *Asking*—traditionally achieved during question and answer sessions, seminars and discussion groups. This can be referred to as discursive or Socratic in nature. If 'asking' is primarily viewed by the teacher as a synchronous activity, technologies such as computer-mediated communication (CMC) or videoconferencing must be used to achieve real-time dialogue. If however, time is to be given for students to reflect more on their answers, other, asynchronous forms of communication, such as electronic mail could be used.
- *Responding*—also achieved in traditional settings through question and answer, discussion and seminar sessions. This is different to asking in that it is essentially teacher initiated. Again, due to it's synchronous nature 'responding' should ideally be in real time, as prompt answers can motivate and challenge students to advance in their studies and can focus the energy of groups [14]. Electronic mail is a viable asynchronous option to apply to this task, if the synchronous methods, such as audio or videoconferencing are not accessible.
- *Discussing*—facilitating group work through collaboration—is the final pattern of communication commonly observed in many forms of

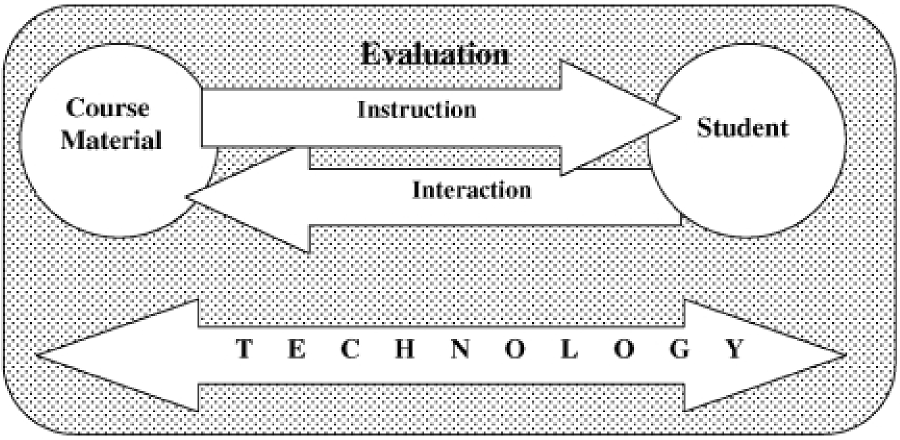

Fig. 3. Technology-supported learning model.

education. Within four walls this is easily achieved. When the group is distributed geographically, this can be problematic. Synchronous and asynchronous formats are equally relevant, depending on the desired learning outcomes. If for example, a group has been tasked to achieve a consensus on a chosen issue, asynchronous computer-mediated communication may be the most appropriate technology, giving students room to think and reflect on their contributions over a period of time. If on the other hand there are visual or audio aspects of the task, a synchronous tool such as videoconferencing or audiographics may be a more viable alternative. Significantly, it has been established that increasing the feeling of community amongst isolated learners through the use of dialogue in peer support can actually reduce drop-out [15].

Technology-supported learning

The use of technology to support distance learning across the south-west peninsula is underpinned by the philosophy that students work and learn within an environment that must be quality assured. Continual evaluation is therefore required. Furthermore, it is assumed that the student is central to the learning process, and that the teacher must therefore play a supporting role. The student thus spends a great deal of time interacting with the learning materials and comes to the teacher when specialist input is required. Figure 3 represents these ideals.

However, there is one important component missing from this particular technology-supported learning model. This is the need to communicate—an important requirement for any student, and vital in distance learning. Communication is of course two-way and may occur not only between teacher and student, but also between students and their peers. Technology-supported communication between teachers and students then, is a priority in any model of distance learning as without it, students are isolated and can become rapidly demotivated. These transactions can be integrated

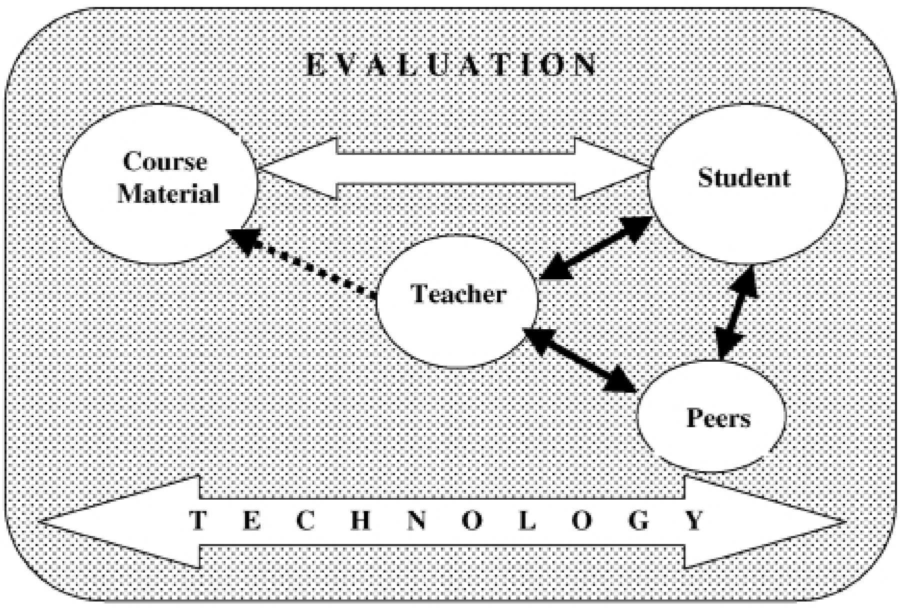

Fig. 4. Technology-supported learning and communication model.

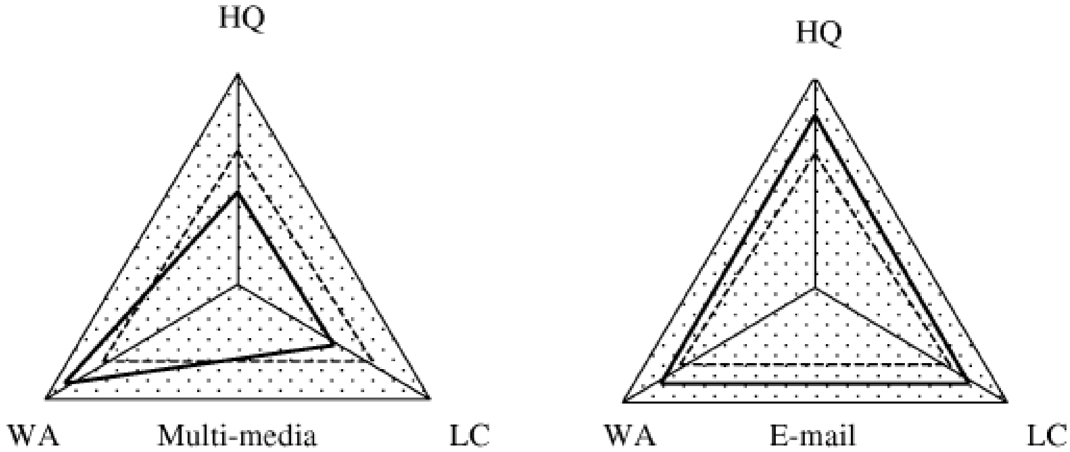

Fig 5. Comparison between sending multimedia files and text (e-mail) via a 33.6 kbps modem.

into the technology-supported learning and communication model represented in Fig. 4.

Benefits analysis

Arguably the most important planning tool that can be applied to the deployment of learning technologies is benefits analysis. In an increasingly unfavourable economic climate, all expenditure has to be defended robustly, and evidence for efficacy is a powerfully persuasive argument. Benefits analysis—the evaluation of how effective the system is in achieving outcomes—is therefore an important part of planning and implementation. Data to support this exercise can obviously be obtained *post hoc* by questionnaire and interviews, but necessarily, assumptions must sometimes be made prior to delivery.

The benefits analysis tool presented in recent papers by the authors [16–18] offer parameters based upon *a priori* assumptions and past experience of delivering learning to distributed student populations.

It is important to note that teachers and education managers who intend to deliver training and education at a distance can create their own parameters commensurate with the budgetary constraints they have imposed. The benefits tool will then ensure that expenditure can be visualised in the context of quality and ease of access to technology.

In Figs 5–7, the dotted line represents the optimum parameter imposed by the education provider in terms of high quality (HQ), wide access (WA) and low cost (LC). Any lines falling outside this dotted triangle represent technologies that exceed these particular parameters. If the line falls inside the dotted line, the technology is considered to be deficient in this area. It should be noted that other parameters such as level of interaction and student perception are being researched at present, but are not included in this model. We shall examine each parameter in turn.

Wide access

Width of access is quantified by the number of students, real or potential, who can participate in learning activities using a particular technology. Ease of access is typically constrained by a number of factors, namely hardware and software availability, ease of use and existing technical infrastructures. Synchronous systems such as audio- and videoconferencing are also constrained by

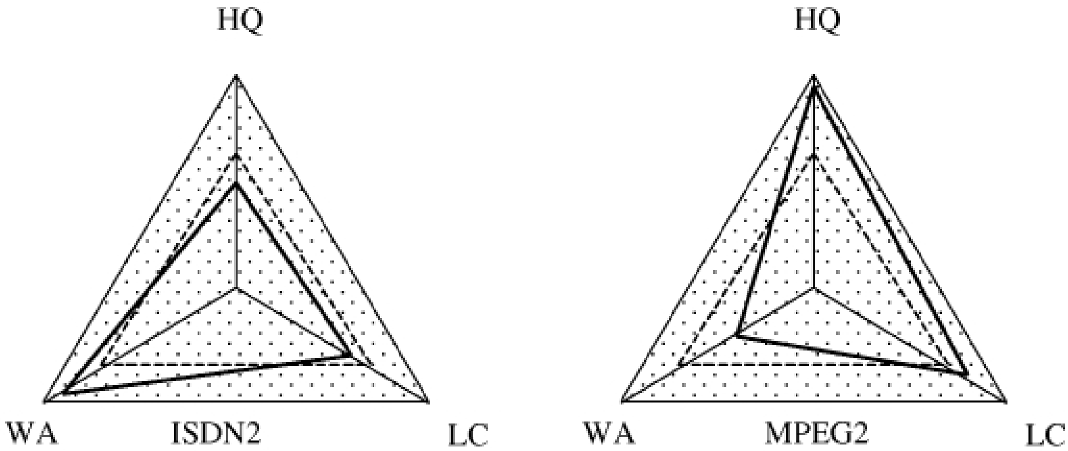

Fig. 6. Comparison between ISDN2 videoconference to three sites and MPEG2 satellite distribution to *n* sites.

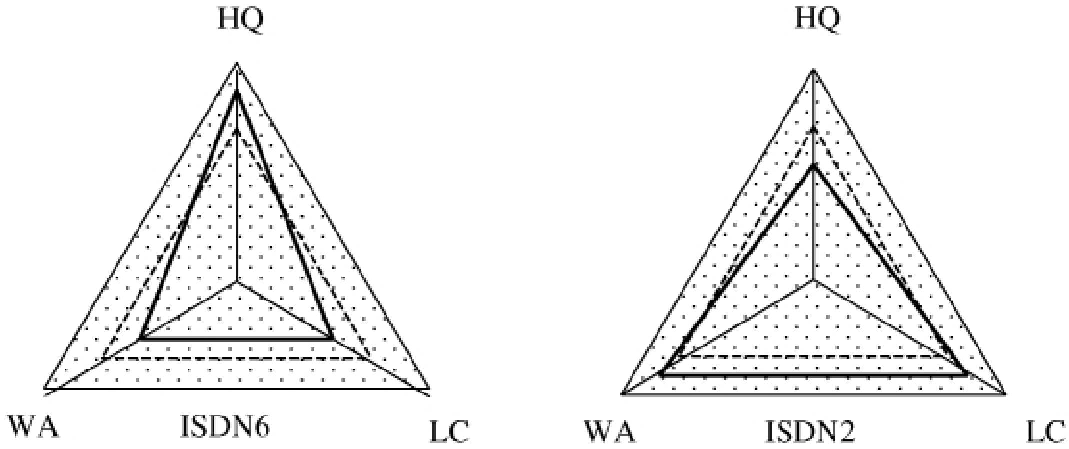

Fig. 7. ISDN6 and ISDN2 videoconference comparisons in point-to-point mode.

time, both in terms of the tutorial staff who can be made available in a designated time slot, and also by differentials between time zones where global dissemination is required. For example, a videoconference organised between two individuals in the UK and Eastern Australia (time difference—11 hours) would require careful negotiation otherwise one party might find themselves having to participate at a very unsociable hour.

High quality

Generally, students are not particularly concerned about the means by which learning materials reach them. What they are more interested in is the quality of the materials, both in terms of how fit they are for the purpose, and also that they receive them regularly and on time. A learning resource is fit for the purpose when it is clear, informative, easy to use and aids the student's learning. Television programmes that are dull, irrelevant or out of date, and websites that offer material that is either too difficult or tedious to read or not easy to navigate around, both fall into the category of low quality learning material. Conversely, high quality learning materials are relevant, stimulating and easy to use.

Low cost

Not surprisingly, this parameter is the first one to receive attention from most educational institutions. From a student perspective also it is important that a course is economically viable, as most students enrol with a view to completing a qualification. Balancing costs against income are the normal *modus operandi* of corporate businesses, and educational institutes these days invariably operate on this basis. Balancing costs against benefits is a more appropriate approach for education. This is a difficult task in traditional education, and when applied to telematic delivery, it is just as problematic. Again, the evaluative model outlined earlier can be brought to bear on the problem.

A worked example of these principles can illustrate the benefits analysis model. A justification of

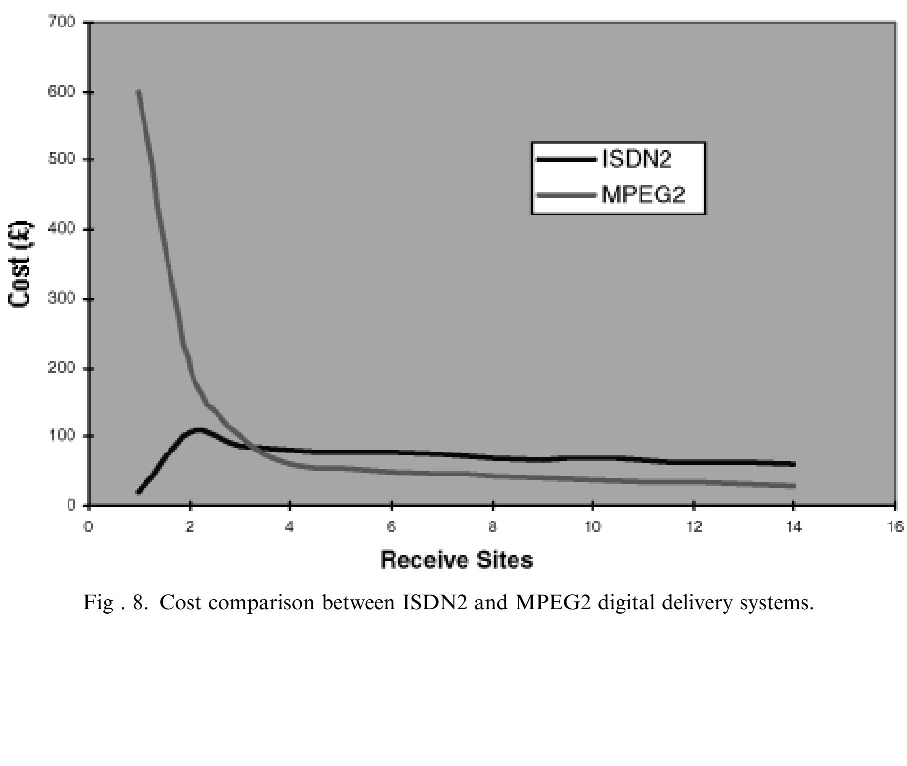

Fig . 8. Cost comparison between ISDN2 and MPEG2 digital delivery systems.

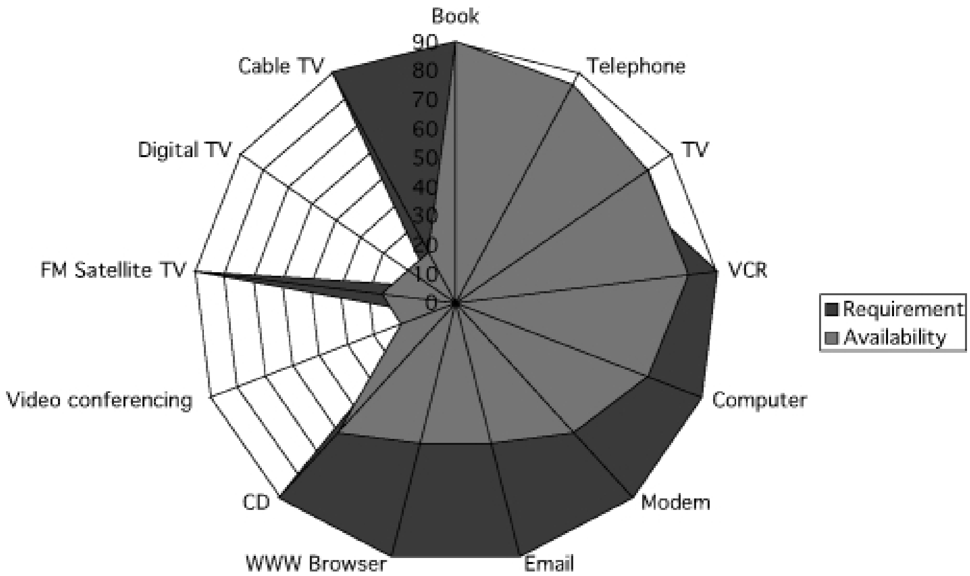

Fig. 9. Integrated technology benefits analysis map.

the variance in price between ISDN2 point-to-multipoint conferencing and MPEG2 digital satellite transmission (Fig. 6) can be seen in Fig. 8. Access to MPEG2 satellite reception is limited in the UK at present, but will become more widespread as the technology becomes more readily available. Prices in the UK based upon ISDN2 receive sites at £20 per hour plus £52 for the hire of a video bridge facility, totalling £72 per site per hour. MPEG2 satellite transmission is based on an overall transponder fee of approximately £300 per hour. Cost benefits are illustrated in Fig. 8.

ANALYSING AVAILABILITY AND REQUIREMENT

Studying delivery methods in isolation is only a part of the solution. In order to see the whole picture, and plan effectively for it however, an integrated systems approach must be adopted. To achieve this a new analysis tool has been developed, and one example of this is presented in Fig. 9. Analysis is based at this level on a measurement of requirement against availability (access). Other parameters can also be applied in the same fashion to indicate cost and quality levels. Deficits in provision can clearly be seen where the darker colour requirements are revealed beneath the availability (lighter colour) mapping.

CONCLUSION

When embarking upon widespread delivery of education at a distance, it is vital that distance educators and planners prepare excellent foundations. It is also equally important that as they build pedagogical and technological infrastructures, they also plan for the future. Those who fail to future proof their activities can expect to fail in the long term. Effective planning can only be achieved by an intimate knowledge of the systems currently available and how they can be applied either singly or in concert to meet the learning needs of students. This can be either in isolation or as integrated systems in order to provide the best possible distributed learning environments.

The authors plan to extend this work further to incorporate other important parameters such as interactivity, information richness and user perception and expectation. These are generally considered to be psychological dimensions and will thus be explored using appropriate evaluative methodologies. The results of these studies will be reported in future publications.

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