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A DYNAMIC MODEL FOR DELIVERING DISTANCE LEARNING MATERIAL VIA INTERACTIVE TELEVISION

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As Distance Education grows in popularity and importance, new formats such as Interactive Television offer the advantage of real-time visual and audio interaction between instructors and students. In the early years, the development of interactive television systems as a medium for distance learning provided the users only with the ability to react to a given linear programme, rather than directly control the programme contents. Research however has shown the emphasis on creating a compelling interactive programme for TV delivery to allow the users to control the content. Unfortunately, while millions of dollars have been spent and a lot of research has been undertaken, the most people have access to, is something akin to a searchable teletext system. According to this discovery, we have been conducting research on interactive educational material production by applying interaction technology to traditional distance learning methods. As an initial step in creating a new type of delivering distance learning material, we have produced a prototype system. This paper describes the prototype system, and outlines its problem areas and required improvements. For our experiments, the NEAB GCSE English Syllabus.1111 provided by the National Curriculum 2000 has been chosen as the content source for delivering distance learning material via iTV.

1 Introduction

Over the past several years, radical changes have occurred in the underlying technology of computing and communication systems. The increasing capacity of wide-area communications and the advances in data compression technology has enabled a variety of new technologies [4]. These new emerging digital technologies such as e-mail and the World Wide Web (WWW) have opened up new directions for experimentation in the field of learning. One recent development is Digital Television. Of most interest is that digital television can support Interactive Television (iTV), which is the convergence of television and the Internet [3], where the end user is involved in the programme content. The development of complementary digital technologies video-on-demand (VOD) and personal video recording (PVR) facilitates the delivery of distance learning material permitting the user to choose when they view the material, the level, for how long and allowing them to store the material on hard disk for subsequent viewings. While existing distance learning programmes are offered on the Internet, learning and knowledge provision is a highly underdeveloped area on iTV, and it could benefit considerably from including facilities other than the predominately leisure and entertainment services such as the sport industry [2] currently available.

Both corporate and academic agendas in UK and worldwide have recognized the potential advantages of distance learning and therefore proceed in the investment towards the implementation of Information Communications Technology (ICT), which has become a legal requirement within schools in UK. The use of iTV as a technological learning aid could then assist both ICT use and general study. Thus, the emergence of iTV and distance learning 'iTV-dL' will mean that aspects of learning will become available to a wealth of people without PCs. The development of iTV as a medium for distance learning has already been undertaken in some specific areas, but predominantly in a purely visual sense, by using only video. For example, in schools, the use of webcams linked to computers at the users home, and then connected to a television screen in the classroom have been already developed in the USA, but this is not iTV as such, it is simply broadcasting over the Internet. New methods must be adopted for interaction technology to make it possible for students to interact with learning materials and control the interactive television pages in the same way that the television itself is controlled. According to this discovery, this paper argues that iTV can facilitate distance learning and add values to this practice.

In the work presented below, we examine the results from our research using the NEAB GCSE English Syllabus.1111 provided by the National Curriculum 2000 as a case study to measure the accessibility and the effectiveness of our system. We discuss results on navigation, organization, design interface and level of user interaction.

2 iTV and distance Learning: 'iTV-dL'

The convergence of Digital Television and Interactivity leads to interactive digital Television [3]. iTV combines the appeal and mass audience of traditional TV with the interactive features of multimedia technologies such as the Web. It is a combination of push and pull technology [1], a technology for delivering television programming on demand to households, and provides a wide range of new services that combine video and data. In the near future, a variety of interactive services are going to be included which will give far greater control to the user.

Distance Learning (DL) on the other hand, is a process whereby the student and the teacher do not have to be present physically on the same location in order to complete a course of study. The advantage of this being that less physically able students, those who live in inaccessible areas or those who are not as financially able, can learn at their own pace and in their own time. DL is, however, for anyone who wants to learn in their own pace, and systems such as the Open University have been incredibly successful at providing ordinary people with degree courses to take at home. One of the most important issues in DL, no matter what the medium, is that the student and the tutor are physically separate.

Television is a technology that everyone can feel at home with, if this can be used as to deliver learning material, aspects of learning will become available to a wealth of people without PCs. This realization is the key to the potential success of iTV. People are guaranteed to use iTV, because they will gain from it, and it is much less complicated than using a PC. According to research conducted by the Athens University of Economics and Business [8, 3], iTV can enhance learning due to the high penetration and acceptance of TV already and considering the fact that iTV will not be more complex to use in comparison to TV. Home users do not need a PC, or any expert knowledge, or a "Computer's Don't Bite" course to undertake first, all they need is a TV, a set-top box (the set-top box decompresses the video and sends it to the TV, and manages the interaction with the viewer via a remote control) [6] and a remote control. The need for distance learning on iTV is still strong, despite the fact that e-learning on the web is already available. In April 2001, David Blunkett the then Minister for Education in UK, announced a new £42 million project to produce digital course materials in six GCSE subjects, giving teachers and pupils instant access to sound, video, interactive and 3-D educational materials [5]. This offering by the government highlights the need to prolong the "e-learning revolution" as much as possible, until as many solutions as can be have been investigated to aid distance learning, and learning in general.

In UK, existing providers of digital television and interactive services are the Sky Digital which provides the interactive service 'Open' which offers 'Telewest Digital', ntl which offers 'ntl Interactive' and ITV Digital which provides a selection of interactive services. Mainly the services provided by the above providers are leisure and entertainment based, and only BBC2 provides educational programmes on UK terrestrial television. Those programmes related to distance learning material are the DynaMo, the GCSE Bitesize, 16+Years (AS Guru), The Learning Zone and the Open University.

- ❖ **DynaMo:** is a programme on the BBC for children aged between five and nine which is supported by website material. All the activities contained within the programmes and the websites, have been created in line with curriculum needs and are designed to complement children's school work in Math's, English, Science and History.
- ❖ **GCSE Bitesize:** The BBC has recently introduced GCSE Bitesize to customers subscribing to the Telewest interactive service. The service offers help with learning, revision and exams, but little content is attempt from the GCSE syllabus.
- ❖ **The Learning Zone:** consists of a variety of educational programmes all of which are aimed at adult learners. The Learning Zone programmes do not currently have iTV site support, but they do have website information to back up the programmes.
- ❖ **16+ Years (AS Guru):** also does not currently have an iTV support site, but has a section on the BBC education website devoted it to as programme support. Subjects include English, Math's, Biology and Study Skills in general.
- ❖ **Open University (OU):** The Open2.net website currently does not have an iTV support but, offers links to relevant BBC websites about specific course programmes, as well as providing OU programme listings for upcoming shows related to specific degree courses. The Open2.net website is a good example of the sort of content which could be found on a prospective OU iTV site. For

example, in our system the 'What's on TV' section, which provides GCSE English programme information for the next two weeks and can be accessed and updated easily from the database, is directly related to the medium on which it is placed. Users could simply press the Interactive button on their remote controls, and find a complete list of upcoming programmes relevant to their course.

Of all the main satellite and cable television providers in UK, ntl and Telewest are two of the few major digital TV providers in the UK to offer any kind of learning facility on their interactive service. Focusing on Telewest in particular, there is an entire learning channel accessible from the main interactive menu, which comprises a series of learning sites, one of which is the Key Stage 3 Bitesize site produced by BBC. The main problem with this service is the poor state of the existing interface with basic interactivity and navigation, issues thoroughly researched and analysed in our system. Below we present the results from our iTV system and examine the viability of learning and engagement in the environment of iTV.

3 The NEAB GCSE English Syllabus.111 Case Study

3.1 Equipment and HCI considerations

A prototype iTV system was developed using a Pentium III at 700 MHz built with, an MPEG encoder/decoder for video compression and decompression. The DTV navigator Set-top Emulator (Emmy) Version 1.1.54 was used for the design and the development of the user interface. The interactive pages were designed by using DHTML and JavaScript while the Personal Web Server (PWS) and Microsoft server-side scripting technology Active Server Pages (ASP) were used for the updating of the programme listings. The emulator enables the site to be viewed, as it would be seen on television, but on the web. It uses only the input and navigation tools available to the home television user, and makes no use of the mouse and traditional methods of accessing information on websites. As Television is fundamentally different from the computer as a medium for presenting information the iTV system has been designed taking into consideration the Human Computer Interaction Issues (HCI) for designing for iTV. The interface can be accessed in terms of usability and functionality, as well as how transparent and intuitive it is to navigate. For this, the use of chunking of certain specific menu choices has proved effective in making the site easier to navigate. In addition to this, knowledge of the primacy and recency effect [8] has enabled the menu lists to be constructed with meaning and relevance.

3.2 Subjects

10 subjects, age range 20-59 with 8 female and 12 male taking part in the study.

3.3 Procedure

Each person participated with a person felt familiar with. The testing audience for the system was comprised of five pairs with different levels of experience with both iTV and distance learning websites. This enabled a fair assessment of the application by a variety of potential users, thus giving more realistic results than if the application has been tested on a user group with the same or similar levels of knowledge and experience in this area. The subjects were given minimal operating instructions and asked to explore the service so that they could report on it after the testing by completing a questionnaire. Lastly, the subjects were interviewed. Trials lasted for about 40 minutes, including 15 minutes interviews with each pair of subjects. A Dictaphone was used to record the interviews and the majority of the questions were open-ended, to allow for as much feedback as possible from the interviewees. The subjects were situated in a home environment at the time of the test and were able to ask questions at any time. The noise levels were similar in the room, compared to where the television was situated, as well as the lighting being quite similar in strength. The keyboard was also positioned further from the screen than is usual for computer use. This enabled the students to have an experience as similar as possible to their digital TV experience.

3.4 Results from the Case Study

The completion of the questionnaire lasted about 15 minutes for each pair of subjects and the testing questions have focused on three dimensions that we found concrete and meaningfully to compare and on a fourth dimension, which was used to measure the possibility of correlation between the three dimensions which leads to high user interaction. The test findings have illustrated that the majority of pages are intuitive, and can be navigated relatively easily. The responses from the survey are shown in table 1:

Table 1. Questionnaire responses from the study with respect to navigation, content organization and design interface.

Subjects = 10 subjects, 2 subjects per pair	5 Pairs	Pair1	Pair2	Pair3	Pair4	Pair5
Navigation = N		4	4	5	4	4
Content organization = CO		4	3	4	3	2
Interface = I		5	4	5	5	4
Variance	Very functional Vf=5, Quite functional Qf=4, Functional Ff=3, Poor function Pf=2 Not functional Nf=1					

3.5 The NCI Model

Our approach is to investigate the ability of a three-dimensional model to expand the traditional considerations for technology-based learning and to examine how the correlation of the 3-D dimensions of the model can affect the user interaction. In our approach the variance describes the spread of the functionality of the iTV system and is given by the equation:

$$\sigma_i^2 = Var(I) = E[(I - \mu)(I - \mu)]$$

where σ describes the spread of functionality within the given data set, and μ is the mean of the data set. In order to check if there is any correlation between the 3-D data set we calculate the covariance matrix, which is given by the equation:

$$\sigma_{NCI} = \sum_n \sum_c \sum_i (n - \mu_n)(c - \mu_c)(i - \mu_i)$$

From our experiments we found that the N,C,I are dependent according to the equation:

$$Cov(N, C, I) = \sigma_{NCI} = \sigma_N \sigma_C \sigma_I$$

and the level of dependency is measured by calculating the correlation coefficient ρ , where $-1 \leq \rho \leq 1$, given by the equation:

$$\rho = \frac{\sigma_{NCI}}{\sigma_N \sigma_C \sigma_I}$$

The covariance matrix in our case is defined as:

$$K = \begin{pmatrix} \sigma_N^2 & \dots & \sigma_{NI} \\ \vdots & \ddots & \vdots \\ \sigma_{IN} & \dots & \sigma_I^2 \end{pmatrix} = \begin{pmatrix} 0.1600 & \dots & 0.0800 \\ \vdots & \ddots & \vdots \\ 0.0800 & \dots & 0.2400 \end{pmatrix}$$

Figure 1 depicts the 3-D dimensional model and its relevant components.

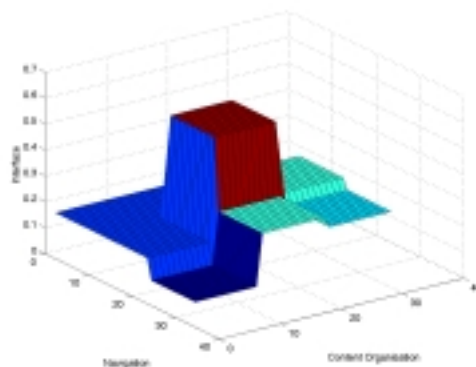


Figure 1. The NCI Model

Figure 1 shows that there is high correlation between the three dimensions with percentages $\sigma_{NC} = 53.45\%$, $\sigma_{NI} = 40.82\%$ and $\sigma_{CI} = 76.38\%$ respectively. According to the results, we have high user interaction with the iTV- dL system when all dimensions have a degree of correlation with the highest one between the Content organization and the Interface.

4 Future Work

In this paper, we explained the concept of interactive distance learning material, the lack of content interaction with the existing technologies, and the structure of our iTV-dL system based on the The NEAB GCSE English Syllabus.111 Case Study. We have then used the NCI Model to identify correlations between Navigation, Content organization and Interface, and analyse how their correlation can affect the user interaction. However, the results have been derived from a small data set. For better classification of the data set and possibility of finding similar characteristics that form clusters between our data set, a higher dimensional feature space should be considered with greater range of data.

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