Design Issues for Dual Device Learning: interactive television and mobile phone

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Abstract

Designers of technological support for learning have an ever-increasing selection of platforms and devices at their disposal, as desktop computers are joined by mobile phones, PDA's, laptops, games consoles, digital television and wearable devices. It is unlikely that a single technology will be a perfect fit for all aspects of a learning task. Many situations will call on the strengths of a number of devices in combination. However, distributing functionality across different devices may create new problems for interaction and interface designers more used to creating consistency and coherence within a single technology. As an example, we describe the design and development of a system that facilitates language learning from a combination of two devices, interactive television (iTV) and mobile phone, drawing on the strengths of each technology. In particular we discuss some of the user interface design issues to be considered in the context of cross platform dual device systems for ubiquitous learning.

Keywords
interaction design, interactive television (iTV), mobile phone, ubiquitous language learning

1. INTRODUCTION

"Beyond the desktop" technologies are currently being harnessed to support many applications for learning - formal and informal, for children and adults, in classrooms and out on field trips, at home and on the move. Each technology of course has distinct characteristics that facilitate some types of use and hamper others. The most successful applications are likely to be those that make the best match between each technology and the function it supports. This may involve distributing the functions of a particular application across different platforms, giving rise to new challenges for the interaction designer who will be called on the produce a design that is coherent and consistent across device boundaries. However, little is known about successful design for such cross-device interactions (Robertson et al, 1996). Each combination, e.g. desktop computer with mobile phone, PDA with wearable device or iTV with Web on PC, will bring different challenges. In this paper we discuss the design and development of the interfaces for TAMALLE, a dual device system for informal language learning. TAMALLE aims to capitalise on the strengths of two technologies, iTV and mobile phones, which tend to be used in different settings. After briefly discussing the potential of mobile and iTV technologies to support language learning, we give a summary of the functionality of TAMALLE with a rationale for its design. We then sketch the interface and interaction constraints involved in designing a unified application accessible via both devices.

2. BEYOND THE DESKTOP TECHNOLOGIES FOR LANGUAGE LEARNING

2.1. Mobile phones

The potential value of learning via mobile devices or m-learning has been widely realised (Leung & Chan, 2003; Naismith et al, 2005; Sharples, 2000). The mobile phone is a particularly interesting mobile technology for learning technologists as it has been very rapidly adopted by non-technically minded users who would not have ready access to laptop or PDA and has woven itself into the fabric of their everyday life. The mobile phone has the potential to enhance learning experiences by providing two way voice communication, by allowing access to learning materials outside fixed times and places and by supporting information retrieval and capture on the move, now including multimedia information. While many researchers have seen the benefits of mobile devices as a supplement to classroom teaching in formal school and college and training contexts, our main interest is in individual learners in informal (i.e. not necessarily curriculum-bound) settings. Here another characteristic of the mobile phone comes into play, its status as a personal companion device. For language learning in particular this is a valuable characteristic. Second Language learners are often to be found with a dog-eared pocket dictionary or a personal vocabulary book about their person, and the mobile can serve as a very natural digital equivalent of these personal technologies.

Several researchers have begun to investigate the potential of mobile devices for language teaching (Godwin-Jones, 2004; Kadyte, 2003; Tan & Liu, 2004). While many of these projects are oriented towards formal education, others target independent adult learners. One project that successfully exploits some of the strengths of the mobile phone is the INLET project (Pincas, 2004), which developed an innovative mobile phone support system to encourage tourists to learn some Greek language at the Athens Olympic Games. The system provided a number of facilities for learning useful Greek phrases in various categories such as "basic" (e.g. greeting, numbers, basic words), "where" (e.g. phrases for asking direction, going

by bus, taxi and trains), "when" (e.g. asking times, today, now, tomorrow), "Olympic Sport" (games name, athletics, fencing, etc.) and "buying" (asking price, money, expressions like expensive, cheap, etc.). Users, typically recruited at Athens airport, were able to register for free SMS messages containing useful phrases to be sent to their mobile phones each day. They could also request on the spot SMS translations from other languages into Greek.

Projects like this use mobile phones to retrieve information about individual vocabulary items and to interrogate information sources about their current context. For instance, a spectator at the Olympic Games might send an SMS asking how to say "pole vault" in Greek during the field events. Other aspects of mobile phones have proved less popular with general users and tend not to be exploited in research projects. Despite the prevalence of SMS messaging, lack of good input devices tends to restrict the length of text entries on mobile phones, so there is little point in designing a mobile application for extensive text composition. Mobiles also tend not to be used for display of long passages of text for reading, probably because of the small screen size, and although advanced phones are now capable of displaying rich multimedia, video viewing on mobiles has not been widely popular and is therefore probably not a fruitful path to follow in educational projects.

2.2. Interactive television

ITV is another new media technology that has great promise for learning (Atwere & Bates, 2003; Pemberton, 2002). Conventional television is already a powerful learning tool for language learners. There is a wealth of anecdotal evidence of individuals learning other languages from exposure to televised soap operas, films and sports reporting. Television offers a rich multimedia experience, where learners can immerse themselves in authentic materials from the target language and culture. This material, unlike some of the stilted exchanges found in text books, tends to be worth watching in its own right, with up-to-date ever-changing content displaying a range of speakers and contexts. Many television shows constitute important cultural events providing a shared reference for people sharing or aspiring to share a culture. In its non-interactive state it is an excellent medium for learners to practice comprehension skills and also to acquire background cultural knowledge (Sherington, 1973).

Subtitling is used on conventional television to support viewing in other languages and also, in the guise of closed captions, to help viewers with hearing problems. Several projects have analysed the use of TV with first and second language subtitles as an aid to comprehension, retention of second language vocabulary and improving reading skills. Studies suggest that even watching TV with an L2 audio track and L1 subtitling could lead to incidental second language learning (Koolstra & Beentjes, 1999; Meinhof, 1998). Koskinen et al (1996) suggest that captioned television can be used as an effective instructional tool in learning vocabulary and concepts. In a study of the effect of captioned television on incidental vocabulary acquisition by adult ESL learners, they assessed vocabulary knowledge in viewers who watched TV with and without captions, identifying "a statistically significant difference in favour of captioned TV" (p.368).

Digital interactive television (iTV) offers new facilities for information retrieval and communications (Gawlinsky, 2003), including the opportunity to go further with subtitling and captioning. The functionality provided by iTV is similar to that provided by simple web sites – mainly hypermedia navigation supplemented by simple interactivity via a return path, enabling voting, buying, mail and so on – but it is displayed on the familiar TV screen. Despite the fact that current levels of interactivity are relatively limited, constrained by the components of the iTV set up, i.e. the set-top box and its software, the on-screen display and the remote control, the potential for developing iTV as a learning technology is clearly vast. This is particularly important for providers aiming to extend learning opportunities to home settings, e.g. traditionally hard to reach groups, such as carers and the disabled, as well as time-poor professionals. Interactive facilities of interest to language learners include:

o   Choosing amongst subtitling or captioning options
o   Viewing supplementary information on screen – to access before, during or after a broadcast (known as "enhanced TV")
o   Accessing web pages on TV
o   Selecting from alternative audio and video streams (e.g. choosing a scientific or generalist commentary stream)
o   Using communication tools such as chat and email.

Interactive TV's strengths, then, are those of conventional TV – provision of current, culturally relevant, video and audio in a leisure setting – plus additional, currently restricted, hypermedia and communication facilities. Like the mobile phone, television has its drawbacks as a technology for language learners. Broadcast TV is schedule-bound, non-interruptible and is often perceived by learners as just too fast (Broady, 1997; Fallahkhair et al, 2004). If a learner is watching alone, using a PVR can remedy this, but at the cost of "liveness", which may be important in watching some programmes such as a sports fixture or a quiz show with its own interactive services. Television viewing is often a group activity, however, and replay via PVR would be unpopular in this situation. In addition, unlike the mobile phone, television is not normally perceived as a personal companion technology, and of course it is not designed for "any place, any time" interaction. It may be that commercial attempts to deliver TV to the PC and mobile phones will eventually capture the imagination of users, but for the moment our model of television is the traditional one of the TV as "digital hearth" (Moores, 1996).

3. TAMALLE PROJECT BACKGROUND

3.1. Learning support

The TAMALLE (TV and Mobile Assisted Language Learning Environment) project was originally planned as a way of testing out the potential of iTV for language learning (Pemberton, 2002). As a result of both our own reflection on the capabilities of the platform and also of feedback from focus group studies with independent adult language learners, we decided instead on a dual device solution combining iTV and mobile phone. The aim of the system is to support advanced learners of English as a second language in their television viewing, as just one element in their language learning activities. As the focus of the learners will be on media consumption rather than on conscious language learning, this support is designed to be as discreet and non-intrusive as possible. The system provides support, in the form of captions and other on-screen displays, for comprehension of specific language (or sometimes cultural) items for viewers as they watch English language programmes. These items can be incorporated by learners into their personal "learning sphere", a private data storage area, which is accessible both via the TV and on their mobile phone. The mobile can further support learners' understanding of the programme by enabling them to access the summary of programme as well as difficult language and cultural items that may appear in a programme. These language items can be accessed prior to, during and after the show. Viewers are also able to add, search and remove items from/into their personal spheres. Even without television, the mobile service is useful for learning the new recommended language items and as a tool for managing personal knowledge.

The following is a brief overview of the system's functionality:

Just-in-time comprehension support

The "Words in Action" function provides textual annotation similar to subtitles on the television screen. The individual items may explicate a word (e.g. Tory = Conservative) or identify a scene or individual (10 Downing St – the Prime Minister's residence). The design locates the call-to-action dialogue on the iTV side rather than the mobile phone since this just-in-time support will only be beneficial during the programme show time and not before or after. However, if the learner prefers not to display annotations on the TV screen, perhaps to avoid inconvenience to others or embarrassment to himself, the "Words in Action" content can be delivered to their mobile phone in synchrony with the programme.

Recommended language items

Difficult or unusual language items from the dialogue or commentary will also be transcribed for TAMALLE viewers in a static list. Viewers who are logged in may select "Recommended Words" to see a list of language items with explanation, which can also be added to their personal learning sphere. The service is also accessible via mobile phone.

Figure 1: Supporting comprehension of difficult language item across iTV and mobile phones
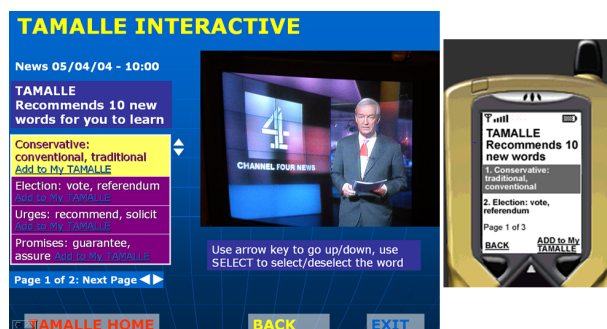
Supporting overall understanding

The viewer's overall understanding may be improved by having access to a summary of programme content. This will differ according to genre, with the news being summarised as headlines, a drama as a brief plot summary and so on. This is augmented by an on-screen learner dictionary, also available on the mobile phone.

Managing personal learning sphere

The system enables learners to manage their personal "learning sphere" via both iTV and mobile interfaces. The recommended words can be added to a personal vocabulary list for later practice. Learners can view all their saved language items from the main menu. They can also search for specific language items and remove those no longer wanted.

3.2 Technical background

TAMALLE is enabled via a learning management system located in the broadcast-end or back-end tier. This provides content to both set top box and mobile devices and also holds learning content or learning objects in a database on the back-end tier (MySQL). In the front-end tier we have the set top box and WAP enabled mobile devices. Two way communications can be established between set top box and back-end tier through telephone modem, ADSL or broadband cable, while mobile phone devices communicate with the back-end tier through the WAP protocol. For interactive SMS messaging we use an SMS gateway provider, in our case the UK SMS2mail provider (for details see Fallahkhair, 2004). This architecture is sketched in Figure 2:

Figure 2: TAMALLE dual device architecture
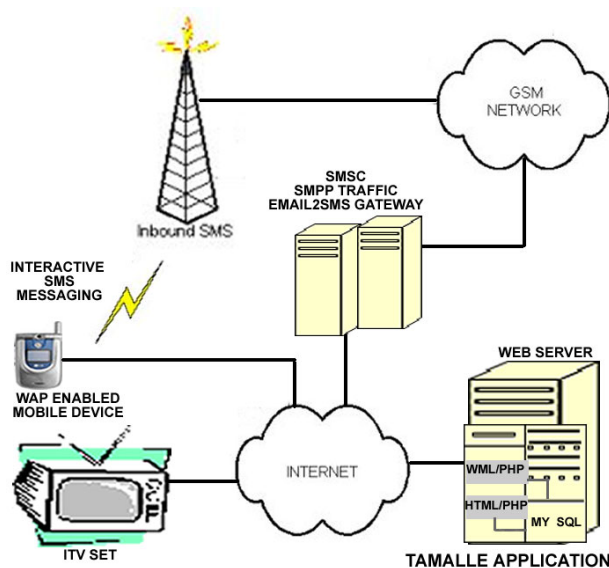
4. INTERACTION DESIGN ISSUES

We have attempted, in designing TAMALLE, to make best use of the strengths of each device and to distribute functionality and displays appropriately across them. However, another design aim was to provide consistency in terms of look (structure, icons, text) and feel (navigation, interaction) across both devices in order to guarantee the usability of the overall system. Many functions can be carried out via either interface, and it would be too much of a burden on the user to expect them to learn different methods for each device.

The physical characteristics and limitations of the mobile phone and the interactive television system, such as screen size, resolution and memory capacity, place heavy constraints on the possible display options and user interactions, which come as a shock to developers used to the relative freedom of PC and Web environments. The typical contexts of use for each device are a source of further constraints: the TV remote has to be usable while watching TV, with as few distracting "head down" moments as possible, while mobile phones are very often used while on the move or in combination with other tasks. In addition, relatively strong conventions have quickly grown up amongst users and manufacturers of these devices, and designers have to be careful to adhere to platform guidelines so as to avoid upsetting users' expectations (or in the case of iTV applications, having their service rejected by platform providers). Unlike a PC or Web service, which will probably be the user's entire focus of attention, TAMALLE will be just one amongst many others – the user will expect them to behave roughly the same as other services on the device.

The conventions of iTV have developed quite independently of those for mobile services, a situation which might cause difficulties for a cross platform design. On the one hand, the system needs internal consistency if it is to be usable, learnable and recognisable as the same application though on a different platform. On the other hand, an iTV service must be consistent with iTV design guidelines if it is to be usable and learnable, and similarly for a mobile service. In this section we set out

design constraints for iTV and mobile services and indicate how they have influenced the TAMALLE design (BBC, 2002; Gawlinsky, 2003; Motorola, 2005; Nokia, 2005).

4.1 Display

The traditional TV screen has an aspect ratio of 4:3, and within this, an area approximately 592 x 480 pixels is considered "safe" for display, i.e. not in danger of being obscured on a particular set. This leaves a remaining 10% around the edges as a "boundary" area, safe enough for backgrounds graphics and so on, but not for key information. Some iTV design involves web-like pages taking up the entire screen, possibly with continuity provide by retaining the audio stream. Other designs involve retaining the video image, typically in the top right hand corner, at one eighth size or larger. Thus textual and other information on an iTV screen tends to be displayed either in an L-shape around the video image, or on a semi-transparent overlay situated to the bottom or side of the full-screen video. A mobile service, on the other hand, once accessed, will typically take up the complete screen, usually, but not always, portrait orientation and may range from 2 x 3 cm upwards. We have tried to display text on the iTV screen in a portrait orientation in a semi-transparent overlay so as to mirror display on a mobile screen.

Text on a TV screen is typically being read from a distance of 2 or 3 metres distance, and needs to be designed with readability at this distance in mind. In the UK, broadcasters have adopted the RNIB's Tiresias Screenfont as a standard, though Gill Sans, Zurich and other Sans Serif fonts are also seen, with a minimum size of 18 point. Colour combinations have a particularly strong impact on TV screen readability, with highly saturated and strong colours casing "seepage" problems when used in combination. Because of the required font size and the limited screen real estate available, ITV services can display only small amounts of text on a single screen. In addition, complex and detailed graphics display badly on the TV screen. Effects such as bolding or other variants may also go unnoticed.

The mobile screen is similarly limited when it comes to text display, though colour may be used with more confidence. Sans serif fonts such as Arial and Verdana are recommended, and font sizes are typically 5 or 6 point. Short chunks of text are recommended for each device, rather than extended passages. Single screens of information are generally found, though some developers have experimented with more complex layouts such as multiple columns. In terms of screen display, then, both iTV and mobile present very strict limitations, but they are not necessarily at odds with each other. Neither platform can support the reading of large amounts of on-screen text and for graphic design options for text are very constrained. We have tried to keep the design as consistent as possibly by using white Tiresias Screenfont on a dark blue background on iTV and the default, rather similar, Arial in black on white for the mobile phone. In addition, although the physical TV screen is obviously much bigger then a mobile screen, it turns out that the amount of text that can reasonably be displayed on each at one time is roughly the same. Problems may arise, however, if the two devices are used together, as the viewer's eyes will have to change focus very rapidly, which is more difficult for those with short/long sight.

4.2 Navigation and complexity

Users of both iTV and mobile phone are essentially limited to a menu-style interface. Although menu items may be graphical in some more modern phones, these are really graphical menu labels rather than the addressable icon objects familiar from the desktop metaphor. Vertical navigation in iTV applications tends to be limited to 2 or 3 levels, with some horizontal navigation between sections of longer articles. Hypertext, i.e. links from individual items embedded in a longer run of text, is rarely found. Complex navigation, whose effects are often compounded by latency delays and also by the fact that TV viewers tend to be less focused on the screen than PC users, is disliked by iTV viewers (BBC, 2002). For mobile phones too, shallow navigation structures are recommended, with no hypertext. In designing TAMALLE, these constraints are tackled mainly by simplifying navigation, making navigation controls very salient and minimising the navigation depth. In particular, it was felt important to keep categories and labels consistent across the devices.

4.3 Interaction

Essentially, interactive viewers can interact with the screen in three ways – navigation, action (e.g. "Set a reminder", "Delete from my favourites list") or text editing. The device used is generally the remote control handset, equipped in the UK with a variety of controls depending on the manufacturer. It may include numerical/character keys, four way arrows, an OK button, volume and channel changing controls, possibly with other specialised buttons (e.g. TV guide, teletext) but it will always provide four colour keys – red, green, yellow and blue, always displayed in that order. While the red button tends to be used as the principal "call to action", i.e. invitation to switch to interactive mode, to such an extent that it is now synonymous with interactivity, it is probably fair to say that the functions of the other three colour buttons, despite platform guidelines (BBC, 2002; Sky, 2005) are not well established and need to be relearned by viewers for each application. Forcing the viewer to look down from the screen to the handset is to be avoided, so designers tend to replicate colour keys, arrows and often numerical keys on-screen, so that the viewer will not have to shift focus. Text entry is tedious (though some viewers use an infrared keyboard) and there has been no TV equivalent of the mobile SMS phenomenon. Mobile phone interaction is constrained in very similar ways. Navigation, action and text entry are achieved via the keypad and arrow keys, with the soft keys playing an important role. Like the TV remote, each mobile handset is different and uses different conventions.

Interaction with the TAMALLE application on the iTV side is via the handset. The red key takes viewers to the home page for the interactive service, in response to a red button on screen as a call to action, the yellow key is labelled Back and leads to the previous page, and the blue key is used to exit the application. Each menu item also has a numerical label allocated to it, giving an alternative selection mechanism. The arrow keys move the selection up and down the list, while the Select key adds a chosen word to a learner's personal sphere. On the mobile phone interface we use the conventions of the phone itself (Motorola): the user can move up and down the list of menu options using the arrow keys and use the right and left soft key to choose an option. The back button in mobile interface mirrors the iTV yellow button. A selected word is highlighted and can be added to the personal sphere by pressing the handset's Select key, giving a reasonable degree of consistency. The use of the mobile and TV in synchronous, co-located mode is currently being investigated, in particular the expectation of co-ordination identified by Robertson et al (1996).

This is an area where the clash of guidelines on consistency is clear. Users expect a new service such as TAMALLE to adhere to platform conventions for their TV and their mobile phone. However, there is no TV handset that currently mirrors works a specific mobile handset, meaning that a consistent interface that crosses devices is not possible. Whether this is a real problem is something we are currently investigating.

4.4 Branding

Unlike most desktop and web applications, services on iTV and mobile phones co-exist in a commercial environment with services from other providers. As Rondeau puts it, brand competition is prevalent on enhanced mobile phones, "with the device, wireless carrier, data provider, third-party software creator and many others trying to gain brand presence in an already complicated interface" (2005, p. 66). This is also true for commercial iTV, where the set manufacturer (Sony, Philips etc), the platform provider (Sky, NTL), the broadcaster of "families of channels" (e.g. BBC, Home and Leisure), possibly the individual channel broadcaster (BBC3, Home and Leisure Bright Ideas) and the production company are jostling for recognition. Physical branding then becomes a part of the drive for usability, as we try to help the user answer questions about what the service offers, who is providing it, what its relationship is to a broadcast programme, who, if anyone, is asking for payment and so on. In other words, clear branding may help the user develop a clear mental model of the service, which will enhance usability. (This is an opposite perspective from that provided by Spool (1996) who was concerned with the effects of usability on strengthening brands). At the moment we are simply using the word TAMALLE as a brand across both devices, but this is a stopgap measure as we look for a solution that instils brand awareness without confusing or distracting the user.

We have touched on four areas where platform design constraints might have created usability problems in a project combining iTV and mobile phone. Designers targeting this combination of devices are in a way fortunate: they are faced with very limited interaction paradigms, but both devices limit design options in fairly similar ways, demanding small amounts of text, menu based interaction, low complexity and a shallow navigation structure. Branding is a problem for both, but any solution found for one device will probably work on the other.

5. FURTHER WORK

There are many unanswered questions both for TAMALLE and for cross-platform design in general. TAMALLE v. 1.00 is currently undergoing usability and acceptability evaluation, both with usability experts and with potential users. Like cross-platform design, cross platform evaluation is a much more complex challenge than evaluation of desktop applications, with both iTV and mobile phones bringing difficulties in their own right (Isomursu et al, 2004; Pemberton and Griffiths, 2003).

Further issues involve the nature of the content provided to TAMALLE users. We are currently conducting experiments with language learners to derive a set of guidelines for selecting elements of the broadcast material for attention. Without such rules to manipulating marked up video, automating the functionality of TAMALLE, which would be necessary if it is to be widely used and sustainable, will not be possible. We are also investigating the most successful format for summaries for broadcast material in different genres. Other areas for further work include the addition of manual input to the personal learning sphere, use of voice output and the possibilities for adaptivity and personalisation.

As far as cross-platform interaction design is concerned, while the heavily simplified facilities of current iTV and mobile phones mean that a "lowest common denominator" solution is reasonable first response to the problem, this situation will change as interaction possibilities become more sophisticated and as more devices enter the mix. Rondeau, for instance, writes in the context of a sports application to be used "on a variety of devices – mobile phones, PDA's, notebook and desktop computes, and interactive television – that would be used in a variety of settings – at home, while travelling, in a sports stadium" (2005. p. 62). The future for cross-platform learning systems is likely to be no less complex and no less challenging.

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