An Alternative for the Interaction with Digital TV

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ABSTRACT

This article considers the use of a barcode reader as digital TV interaction device. With the digital TV, t-learning arises as an opportunity to facilitate the learning to a large amount of people spread all over the country not covered by traditional e-learning. However, TV is not an adequate media for the reading of large texts. Alternatively, paper provides excellent readability properties and it is ubiquitous, portable, easy to use, inexpensive, can be annotated easily. But paper is a static media and does not offer capabilities such as dynamic content and linking that may be provided with digital media as a digital video in the TV, for instance. Nonetheless, the use of a remote control on digital TV requires a complex customer interaction that may cause the user's frustration. This article aims to offer an alternative linking between paper and digital TV, in order to obtain better user interface and encourage an easier interaction in t-learning.

Categories and Subject Descriptors

H.5.2 [Information Interfaces and Presentation]: User Interfaces.

General Terms

Design, Human Factors, Measurement.

Keywords

Digital TV. Usability. Paper Interface. Learning Object.

1. INTRODUCTION

Paper is ubiquitous, highly portable, easy to use in a wide range of environments, inexpensive, can be easily annotated and provides excellent readability properties [18]. Previous research showed that the use of paper is persistent just by the physical properties of paper, not despite these properties [23]. Johnson et al. [23] claim that paper utility will not disappear with the increase of the electronic world, consequently the main goal should be integrating, not removing paper from the electronic world. Sellen and Harper [39] predict that paper, as support of reading tasks, will be one of the hardest media to be moved to the digital world.

O'Hara and Sellen [30] suggested that the critical differences (between using paper and any digital media) have to do with the major advantages that common paper offers in supporting annotation while reading, quick navigation, and flexibility of spatial layout. These, in turn, allow readers to deepen their understanding of the text, extract a sense of its structure, plan for writing, cross-refer to other documents, and interleave reading and writing. However, paper contents representation are static and do not offer any special capabilities such as dynamic content and hyperlinking that can be provided with electronic media, with a digital video in t-learning through the digital TV, for instance.

Previous research has shown that the use of remote control in digital TV produces complex interaction that can cause frustration and irritation to the user [6]. Other researchers have shown that the ease of use is one of the most important factors for digital TV [4, 9, 16, 22, 24]. In order to solve this contradiction, we present an alternative to integrating the paper with digital TV to achieve better usabilility and promote more agreeable environment to t-learning.

The next section introduces t-learning and presents advantages and disadvantages for the learning use of TV. In section 3 discusses usability emphasizing digital TV usability. Section 4 presents related work. In the section 5, a description of the developed architecture is shown. Section 6 shows the learning object implemented. Session 7 describes the usability tests. Finally, section 8 presents the conclusions and future works.

2. T-LEARNING

Bates [2] has identified a big potential for the use of iTV for increasing learning opportunities in the home, in particular through personalized options and also the need to find ways of utilizing the powerful combination of broadcast TV and interactive services to provide hooks to draw viewers into active learning environments. But iTV success requires technological solutions, sustainable models which address pedagogical issues, however, there is still limited research in the area, especially on interactivity and learning aspects [2, 25].

This is an important field in the emerging era of lifelong learning, as learning will take place in a wide variety of contexts and locations and non-formal learning will become as important as formal learning [2] demanding flexible environments. Global access to information and technology is changing the relationship between people and knowledge, and the trends in convergence, integration and co-existence of various media technologies is creating new opportunities for the globalization of learning practices.

T-learning is closely related with interactive access to video learning materials within the home or other locations like school, workplace or community learning centre, through a TV or a device more like a TV than a personal computer [2]. The same author shows a number of reasons why it is important to consider the role that interactive digital TV presents relation within a broader e-learning strategy:

- Most people have access to a television in their home;
- Not every household will have an Internet-enabled computer;
- The TV is an easy to use device;
- People tend to trust the content that is on the TV;

- The TV has the potential for reaching more people and offering learning opportunities, more than what traditional learning institutions can do.

Aarreniemi-Jokipelto [1] identified other reasons supporting the use of digital TV for learning purposes: Accessibility; Interactive services; Independence of time and place; Low threshold for starting use e Learning on demand.

Aarreniemi-Jokipelto [1] also argued that learning is an activity that should be time and place independent and digital TV supports this class of e-learning. In addition, digital TV has greater importance compared to analog broadcasting since it has two-way and feedback features. Damasio [12] identified the potential of digital TV to provide motivating, engaging, and effective media for everyone, whether the learning takes place at school, at home, or elsewhere.

3. USABILITY

Usability has been defined as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [21]. Usability relates to the effectiveness and efficiency of interaction among users, their tasks and the task environment [15]. Effectiveness means that the user is able to carry out the intended task, efficiency refers to the implied time, and satisfaction defines how acceptable the system is to the users [28]. Usability has been traditionally associated with and can be measured in terms of a number of attributes: learn ability, efficiency, memory ability, frequency and severity of errors, and subjective satisfaction [28]. Usability testing is always carried out to test a service or a product, not the user [28]. In learning, bad usability affects the learning process and time is wasted with the system, instead of spent in the learning process. In addition, people refuse to use a rigid, slow, and unpleasant system interface stimulating the course interruption [11].

The primary electronic multimedia device in the home is the television (TV) set with its basic input device: the infrared remote control. The transition to digital TV has changed the television concept; new services and applications are provided through this standard input interface. Recent attempts try to integrate the computer and the TV to provide a home terminal suited for entertainment as well as an information supplier [41]. These attempts have various problems, e.g. economic, technical and usability difficulties [6]. One of the main problems that challenge the home digital terminal is the complex information navigation through the remote control device. This problem is caused by the attempts to design the digital TV as a computer but with the same conceptual model of the so-called 'traditional TV' approach that produces a complex interaction [6] through remote control devices that tend to be big, containing many buttons and controls not easy to be employed [27].

New means of user interaction for the television include voice control [5, 33, 40], Personal Digital Assistants (PDAs) [36], and touchpad devices [14] which address the drawbacks of traditional remote controls such as the overabundance of buttons and controls and the lack of alphanumeric input. Another possible approach was ignored in the digital TV context is augmentation of physical paper. Previous research emphasizes the need of integration of digital computation with physical paper in order to obtain the best properties of both [37]. From an interaction standpoint, paper-based media provides many advantages that are difficult to capture in a traditional graphical user interface [39]. This approach can be a solution for the TV interaction problem.

3.1. Devices

Prata et al. apud Robertson [36] states that any attempt to create a taxonomy of devices will be a complex problem since device usage patterns change over time and vary depending on the combination being used. Thus, the best approach is to study in detail each particular situation, namely, start by studying each particular device characteristics, its specificities, and cognitive and affective aspects associated to its use; and based on that information, design the interface and the interaction model. So, we are studying the barcode reader as a digital TV device in order to design the best way to use it in the digital TV environment.

When compared with the TV, employing a PC: usually involves "one-to-one" transmission, users with different speed connections, frequent technical problems, unsafe environment due to hackers and less contents production costs; allows flexible interaction via a mouse, flexible customization, horizontal and vertical scrolling, several simultaneous windows, flexible interface, implies more homogeneous public, user individual activity and interaction, requires users lot of attention and concentration, users accept relatively delayed interactivity, users have specific goals and modes of interaction: more interactive. Compelling interface and entertainment features are desirable however not absolutely needed and ease of use [35]. When compared with a PC the digital TV implies a broadcast transmission, viewers with the same speed connection, fewer technical problems, a safer environment, expensive contents production, limited interaction via a remote control, limited customization, limited vertical scrolling, only one window at a time, a more heterogeneous public, wide audience, a relaxed and comfortable position, requires less attention; for this environment a compelling interface is fundamental, ease of use is not enough and leisure is needed [2, 10, 13, 15, 17, 34].

4. RELATED WORK

Paper as human interface has mainly been studied in the workplace environment [23, 38, 39] and compared to computer-based interfaces [20, 42]. Berglund et al. [7] have investigated the use of the paper as an interface to digital TV. They analyzed the potential of augmenting paper-based guides by linking them with TV technology. Results show that such guides help to access, read and find information. However, they are passive, isolated from the TV environment, and do not provide cognitive help. As a result, advantages and disadvantages of such guides are related to the physical properties of paper. The drawbacks may be eliminated by adding digital technology to provide interactive and TV-connected paper-based guides. The study provides design implication suggestions for a new concept called Paper Remote which is an interactive paper-based TV guide and a remote control for the TV.

Paper Remote is a concept for linking such guides with the digital TV and it allows people to access TV content with a digital pen. Results of this research indicate that digital pen and paper may be, to some extent, suitable for TV interaction. The Paper Remote concept preserves the properties of paper and at the same time adds interaction and computation technology which augment viewers' interaction. Paper Remote is a computer-augmented TV

guide that also functions as a remote control for the TV. Viewers tick designated areas on the printed guide to perform actions such as channel switching, getting more information, programming recordings of TV programs, and interacting with TV program providers. In their study an initial usability evaluation of the Paper Remote was conducted. In summary, results suggest that this concept provides straightforward interaction and is appropriate for the TV setting.

5. PAPER AS AN INTERFACE FOR DIGITAL TV

The aim of this article is to offer an alternative to support the production of educational text material printed in paper. It will also contain links for digital TV videos. These links will be printed in the form of barcode (Figure 1).

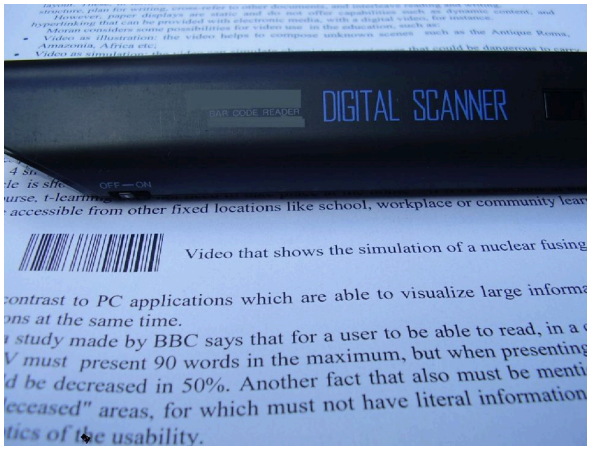

Figure 1. Example and barcode reader

Students must have the educational text material printed in paper and access to the digital TV channel offering the course, and a set-top box for download and storage of the digital videos. In the case where the student wants to watch a video about a study topic, it is enough to scan the desired link, e.g., in the barcode that is related to the video (Figure 2(1)). The barcode reader recognizes the code and sends a request to an application that is executed in the set-top box (Figure 2(2)). After that, the application locates the requested video which is stored in the set-top box and displays it (Figure 2(3).

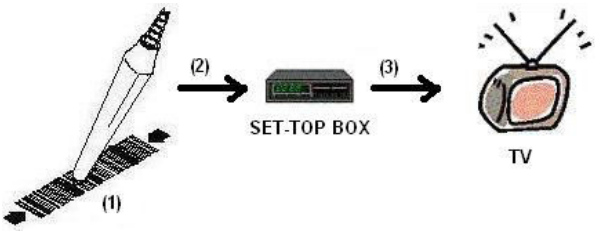

Figure 2. Example of interactive use

The interaction is local, between the user and set-top box, in the case where the user has access to a return channel, the set-top box application will send selected student information to the teacher for feedback. Digital videos are being created on the basis of the constructivist theory of Jean Piaget [32]. Among other things, this theory states that the learning occurs during the interaction of the student with the object of study. This approach applies the interactivity available in the digital TV for the creation of interactive videos turning a passive viewer into an active student.

6. INTERACTIVE SEESAW

In this paper, the above-mentioned application that it is carried out in the set-top box is a learning object (figure 3) and it can be downloaded by the data carousel and stored in set-top box. Another alternative is that the learning object may be available on the Internet and can be stored on a removable memory unit such as a pen-drive.

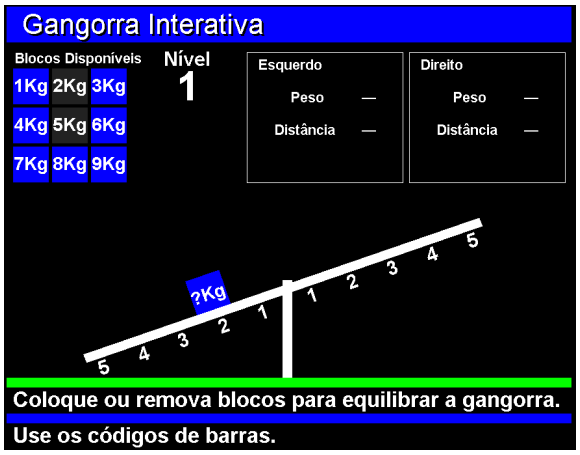

Figure 3. Interactive Seesaw

The learning object implemented is based on another learning object called Gangorra Interativa [26], which simulates a seesaw like those found in playgrounds. The objective of this learning object is to balance the seesaw, placing and / or removing blocks of different weights on the sides of the seesaw. On each side of the seesaw exists 05 (five) positions to place the weights. The weights have the following values: 1 kg, 2 kg, 3 kg, 4 kg, 5 kg, 6 kg, 7 kg, 8 kg and 9 kg.

To interact with the learning object, the viewer learner will use a sheet of paper with printed barcodes. This sheet has barcodes for the following operations: "put block on the left side", "remove block on the left side", "put block on the right side", "remove block on the right side", "next level" and "restart level".

In addition to the operations mentioned above, the sheet also has barcodes that correspond to the combination of weight with the position of the seesaw. For example, if the viewer learner wants to put the block of 6 kg in position 3 on the right side of the seesaw, he/she must first scan the barcode of the operation "put block on the right side" and then scan the barcode of the intersection weight of 6 kg at position 3. The block on the seesaw with the text "? Kg

"means that the block has its weight unknown (no information). Thus, the viewer learner must first identify the weight, so that he/she can balance the seesaw. Moreover, the viewer learner may only use the blue blocks (blocks available). The transparent blocks are unavailable.

The Interactive Seesaw has 5 (five) levels. Level 1 starts with 1 (one) block without information about its weight on the left side of the seesaw and 2 (two) blocks unavailable. Level 2 starts with 2 (two) blocks without information about their weight on the left side of the seesaw and 2 (two) blocks unavailable. Level 3 starts with 2 (two) blocks without information about their weight on the left side of the seesaw and 4 (four) blocks unavailable. Level 4 begins with 1 (one) block on the left side and 1 (one) block unavailable. In levels 1 to 4, the student may place and / or remove N blocks on both sides to balance the seesaw. Level 5 begins with 1 (one) block on the left side and 1 (one) block unavailable. At this level, the student can put only 1 (one) block on the right side to balance the seesaw.

The learning object was performed in a notebook, but it was shown on a TV screen (figure 4). To allow interaction with the object of learning, the reader barcode was attached to the notebook via a USB port. Thus, the interaction with the learning object was very close to reality as the participants did not notice that they were interacting with an application running on a notebook, but with an application running on TV. The learning object was implemented using the Java language, specifically the Java TV API. The prototype was tested with the emulator XleTView used to simulate the TV.

Figure 4. Participant in the tests

7. USABILITY TESTS

Usability tests were carried out, in accordance with the model stated by Pemberton and Griffiths [31]. The tests were performed in a room of the Federal Institute of Piauí (IFPI). Because it is a quantitative study, Nielsen [29] recommends 20 users for usability tests in this type of study. Thus, we obtained the participation of 25 students of this institute. Of the 25 participants, 6 were female and 19 were male. Only 1 (one) already had experience with DTV and 15 have used a learning object in the computer. However, none of them used a learning object in the DTV.

For the tests, the participant was placed in a room containing a sofa, a notebook, a TV and a barcode reader (Figure 4). The notebook was responsible for the storage and execution of the learning object and the transmission of audio signals and video to the TV. In tests, observation user methods, thinking aloud, interviews and usability questionnaire [28] were applied. The test was divided into three phases.

In the first phase, the participant was asked to fill in the consent form and a pre-test questionnaire with some personal information (name, age, sex etc.) and information about him/her experience in the use of DTV and learning objects. At this stage, the material printed with barcodes was shown to participants and demonstrated how to use the reader to scan the barcode. In addition, it was shown how to use the learning object. At this stage, we sought to obtain the participants familiarity with the reader barcode. In the second phase, participants had a few minutes to handle the reader barcode, but also to use the learning object.

In the third phase, was asked the participant to initiate the test. At this point, the participant should use the barcode reader to use the learning object. At the end of the test, the participant was interviewed and he/she was asked to fill out a questionnaire with questions about the use of the learning object and the SUS usability questionnaire [8]. Each session lasted around 26 minutes.

In the tests, errors were not detected by the participants in the act of scanning the barcodes. The SUS questionnaire results were also quite favorable, achieving a score of 78.4 points on a scale of 0 to 100 points. The test results showed that there is the possibility of using the barcode reader like a device to interact with the TV.

8. CONCLUSIONS

The aim of the research presented in this paper is to propose the use of a reader barcode as a device to interact with digital TV (DTV), using an interface of paper with printed barcodes. As contributions, we can highlight:

- The linking of media (paper and TV) in order to promote better usability for DTV, through a technologically simple and relatively inexpensive;
- The design of a new remote control for the DTV, with a reader barcode embedded. It is not intended to replace the remote control, but offer an alternative interaction with the TVD using a barcode reader.
- The potential of the learning object to support the conduct and implementation of cognitive strategies for problem solving to allow the construction of knowledge.

For the students who participated in the tests, there was awareness of the pedagogical value of the learning object. The test results lead to the conclusion that the technology was considered friendly and that the problems were considered normal, part of a process of taking note of a new technology. This notion is fundamental to the successful implementation of a new media or new technology..

It is evident, as described in the previous sections, the importance of the integration of paper as textual content distribution and the digital TV for the education. The main advantage of such media integration is to make the digital TV more user friendly. As a consequence of the better usability, it is expected a major increase in the motivation and learning.

As future works, it is intended to develop a model for the educational text material printed in common paper and electronic material, and to build an authoring tool for the material printed and digital videos.

This work is integrated with a national research oriented to support the Brazilian digital public TV implementation and will contribute to the user centered design and its results will influence the interaction design with digital TV.

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