Learning Objects for use in Interactive Digital Television

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ABSTRACT
Digital Television in Brazil is being implemented with extensive support of public policies to promote social inclusion through e-government services and the formation of a network of distance education. The Interactive TV (iDTV) allows a lot of services that combine video and data offering the user more control over the content and services compared to traditional services of TV, thus becoming an interactive form of communication. Consequently, new content should be researched and developed in the form of learning objects (LO) specifically for T-learning. This article aims to discuss papers existing in international databases whose subject is about adaptation of LO to the context of iDTV. The results of the research have presented that there are several initiatives for the production of LO for iDTV in the world, with emphasis on the T-MAESTRO project and the ATLAS project in Spain and the BEACON project in Brazil/Europe. However, it is perceived that the development of the content and services are in the beginning, because today is largely used primarily for the information and communication technologies and should be adapted to iDTV.

Categories and Subject Descriptors
J. [**Computer Applications**]: Education.

General Terms
Theory.

Keywords
Interactive Digital TV, Learning Objects, T-learning, iDTV.

1. INTRODUCTION
The information and communication technologies (ICTs) offer various tools that are used for distance education (DE). Presently, DE courses are based essentially on the Internet, which can be accessed from a remote location and facilitates studies for those who are unable to perform them face to face.

According of a survey on the use of ICTs in 2009 say that 98% of Brazilian households have a TV set and only 27% have a computer with internet [1]. Known the existence of the television in Brazilian households, one of the purposes of the exploitation of Digital TV is to promote social inclusion to a significant part of the population and encourage the creation of a national network of Distance Education [2].

The Interactive Digital TV (iDTV) presents significant offerings to increase of educational services, with the option of interactivity of users via the remote control with content broadcasted on television. As a result, it is necessary that the digital content for educational purposes is often adapted for reuse, as well as the searching of such content should be facilitated by the information contained in them. Creating Learning Objects (LO), which are dynamic and personalized contents to different levels of interactivity user's [3], broadcasted through iDTV is the subject of this study.

The knowledge about work-related studies in LO provides subsidies for researches that are being carried out at the Federal University of Santa Catarina (UFSC) in the Research Group on Human Resources Training to Content Production and Services in Digital TV (HRTVD) that has support of the Brazilian Government through the Coordination of Improvement of Higher Education Personnel (CAPES).

This paper investigates works whose theme is the development or adaptation of contents for DE in the form of learning objects for iDTV. In section 2, the iDTV and its participation in programs of DE are discussed. In section 3, the concept of t-learning and some assumptions for the development of LO are presented. Then, definitions for LO, its uses and applications in iDTV are presented (section 4). Finally, some case studies found in the systematic review in section 5 are commented, followed by conclusions.

2. INTERACTIVE DIGITAL TV (iDTV)
Interactive Television (iTV) is considered as the convergence of two different technologies: television with computer technology (more specifically the Internet), which adds the component of interactivity [4].

With the introduction of digital technology, greater access has been opened in various areas of knowledge and also to the field of education. As the growth of the courses accessible through the Internet, the expansion of e-learning currently discovers a new media with iDTV. The chances of success in using the iDTV for

DE are many, as pointed out in studies of several authors [4], [5], [6], [7], [8], [9] and [10].

By Decree 5820 of 29 June 2006 was defined the deployment of the Brazilian System of Digital Terrestrial Television (SBTVD-T), that is a platform for transmission and reception of digital terrestrial broadcasting of audio and video. The decree established that the SBTVD-T should allow digital transmission simultaneous for reception fixed, mobile and portable and interactivity [2].

The SBTVD-T is considered the standard of most advanced digital TV, because it modifies the ISDB (Japanese System) integrating new technologies, such as Ginga, the middleware developed in Brazil and video compression MPEG-4, brought from Europe, which is a more advanced version of standards used in digital TV until now.

Ginga is the intermediate software layer between the Operating System (OS) and the TV applications. It is an open source middleware, used in SBTVD-T, developed by Catholic University of Rio (PUC-RIO) and Federal University of Paraíba (UFPB). Ginga is the responsible for supporting the interactivity; it allows easy and fast development of interactive applications for iDTV.

It is important to be highlighted with the establishment of SBTVD-T that, in addition to mobility and portability, the system has interactivity as a competitive advantage that promotes the creation of various applications and services, among them those that stand out for DE.

According to [4] the main characteristics of iTV are: (a) personalization – in iTV refers to the use of ICTs to knowing the viewer information, to adapt the interactive content to each individual viewer profile, (b) digitalization – technological advancements that allow better quality audio and video, and (c) interactivity – which term refers to greater control of contents, directly in the hands of user or potential customers on the network.

A survey on the use of ICTs in Brazil indicates a scenario where 98% of Brazilian households have a TV set. The mobile phone is 82%, computer 34% and the Internet, candidate for the interactive channel, with 27% of penetration in households [1].

Due to great penetration of television, the digital TV emerges in Brazil with the clear objective of promoting social inclusion to a significant portion of the Brazilian population through content and services [2]. The migration to digital technology can be made by the people gradually, as they do not need to change the TV sets to have access to the reception of digital signals. By the purchase of a device called set-top box (STB), that make the conversion of the analog to digital signal, also allow interactivity.

Distance Education is one of the possibilities of iDTV pointed out by [7], which mentions Brazilian projects such as Mídias na Educação and TV Escola (Media in Education and School TV) in order to reduce the high rates of illiteracy and functional illiteracy in Brazil. Currently, it is not possible to think about education without dissociate her from communication and media, in times of new technologies even the concept of education needs to be expanded. DE must be aimed at the democratization of information and social inclusion, but it should be emphasized that before the use of iDTV for DE the users must be digitally literate [7].

With the new paradigm presented by iDTV, one of the main developments is the interactivity, when associated with the return channel, increases the potential for use in education. Just as the interactivity of the iDTV must change the attitude of viewers to active participation in television programming, content development for educational purposes for iDTV is a key factor for successful use of this new media for DE.

3. T-LEARNING

The term t-learning appears with different definitions, it can be an abbreviation for the meaning of learning based on interactive TV, which can be described as the convergence of media: the interactive TV (TV + computer technology) and e-learning [4], whose definition is illustrated in Fig. 1.

For the use of DE in the iDTV, it is important to rescue the characteristics mentioned by [4]: personalization, digitization and interactivity.

Personalization suggests that a potential student-viewer could easily tailor a selection of available t-learning services according to his/her interests, as mentioned in [11]. The ability of service adequacies can help filter the knowledge about the viewer to make their purchases more specific and effective.

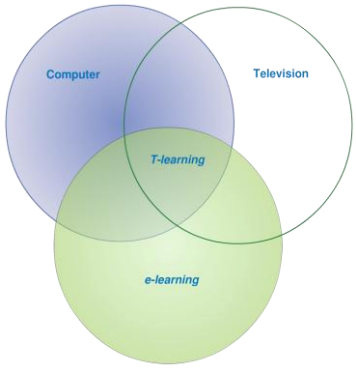

Figure 1. Convergence of technologies for t-learning. Source: adapted from [4].

With the interactivity there will be the possibility for the student to interact with the available content and with other participants in the learning system, such as other students or teachers [4]. According to [12] the interactivity may be available in three ways: locally (with the TV and without return channel), through a unidirectional return channel and through a bidirectional return channel.

Generally, the goal of the applications of e-learning is to present a course based on LO, personalized and interactive, where data on student profiles are used for the extraction of learning content. The incorporation of dynamic features in the applications of e-learning, as well as the establishment of standards for reuse and coding of content is fundamental [4].

The research on e-learning made by [4] provides some theoretical knowledge relevant to t-learning, as well as various standards

and tools for content management and student monitoring [11]. But there is much work to be done to adapt the peculiarities of e-learning to the iDTV environment, due to the limited computing power of set-top boxes and the limited capacities of interaction of the remote control [13].

In order to investigate the peculiarities of the LO in iDTV environment, a systematic review in the major databases available on the Internet was carried out, which will be addressed in the next topic.

4. LEARNING OBJECTS

4.1 Conceptualizing learning objects

The study of LO is recent and there is no consensus among authors on their definition [14], [15].

A learning object can be defined as any digital resource that can be used to support learning, and have characteristics such as elements of a new type of computer-based instruction grounded in the object-oriented paradigm of computer science. The object-oriented values the creation of components that can be reused in multiple contexts [16].

In order to facilitate the adoption of the use of LO, the Institute of Electrical and Electronics Engineers (IEEE), through the Learning Technology Standards Committee (LTSC) has developed the standards for use in instructional technology, which defines LO as any entity, digital or non-digital, which can be used, reused or referenced during technology supported learning. Technology supported learning can be, *e.g.* computer-based training systems, interactive learning environments, intelligent computer-aided instruction systems, DE systems, and collaborative learning environments. As LO are included multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning [16].

According to [17] LO are: digital resources, which can be used, reused and combined with other objects to form a rich and flexible learning environment. While [18] says that such objects are nothing more than pieces of didactic contents in the digital environment (with sounds, drawings, animations, pictures, videos, recordings, photos, documents, texts and activities) and can be used to teach the same subject in different disciplines and courses.

Note that in all these definitions about LO, there is the need for reusability and interoperability, so that with the application of standards they most likely will be compatible with different types of Virtual Learning Environments (VLE) found in Web.

To ensure the reusability of LO, it is necessary to make it according to some standards of description, facilitating the acquisition, location and identification of LO for its effective reuse. This standard description is also known as metadata.

Metadata, or data about data, provide information, physical or digital, for a particular reuse of LO [3] "promoting interoperability, identification, sharing, integration, use/reuse, recovery and management of these more efficiently". Metadata can contain information about the title, author, date, publication, keywords, description, location of resources, its objectives and characteristics, showing how, when and by whom were stored and how it is formatted.

Several companies and organizations are engaged in implementing metadata for LO: the DCMI (Dublin Core Metadata Initiative) [19], IMS (Instructional Management System) [20], SCORM (Sharable Content Object Reference Model), e.g. [21], among others. The LOM (Learning Object Metadata) is a standard that highlights from others for its acceptance among researchers and because it is developed by the IEEE as the basis for other standards mentioned above [22].

The Federal University of Santa Catarina has conducted researches within LO for DE. The Project of Research and Development of Platforms for Production and Dissemination of Digital Contents (PLACODI) is one of these examples which has the aim to obtain specification of technical and functional requirements for developing a platform for production, editing and distribution of interactive digital contents for use in applications of DE, allowing the interoperability of content in web environments and digital terrestrial television.

One of the stages of this project was to describe and compare, based on a set of criteria, the major industry standards for developing content for web environment. As well to standards for metadata mentioned above, the research included in the analysis MPEG-7, MPEG-21 and TV-Anytime, whose findings showed that the ideal for interoperability between Web and iDTV is using a combination of standards rather than only one [23].

4.2 Learning Objects in Digital TV

The content provided by iDTV is a package of digital multimedia content that can contain video, audio, images, software and data [3]. The content used in iDTV can be reused in different situations, including for educational purposes can also be considered as a LO. In Fig. 2 is represented a package of LO for digital TV.

The authors [3] added a new term by creating the Learning

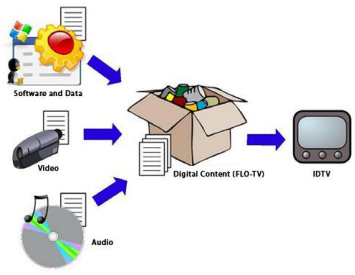

Figure 2. Digital Contents in iDTV.
Source: adapted from [3].

Objects Functional directed to Digital TV (LOF-TV). This differs from others only by the media to which it is applied. LOF are computational artifacts whose functionality should enable the interaction between entities, be they digital or not, and can be used/reused in mediating the process of teaching and learning. E.g. chats, forums, file repositories, smart objects [24].

In the next section, the results of systematic review on the case studies are presented.

5. FINDINGS

In order to support the research that has been developed at UFSC for content and services for digital TV and summarize current trends on learning objects, the aim of this section is to build a theoretical basis about the creation of LO for iDTV.

The search of contents was made by a systematic review in the major databases available on the Internet. The searches were conducted in November of 2009, containing the words: learning objects, Digital TV, DTV, iTV, iDTV and DTVi always in combinations like "learning objects" + "Digital TV" or "learning objects" + "DTV" and so on. The fields of the searches were Title, Abstract and Keywords, with the orientation to show only results with free full text available. The databases were chosen in this order: (1) Scopus, (2) Web of Science, (3) ERIC, (4) SciELO and (5) Google Scholar.

The databases from 1 to 4 had zero results for the combined terms ("learning objects" + "Digital TV", e.g.), only when searches were done with the term "learning objects" there were records, but none of the abstracts read indicated iDTV content. Google Scholar found 536 records, but many were not in full text, nor linked to the subject of iDTV. In total it was possible to collect 32 articles, books or book chapters and other documents (reports e.g.) that had LO and iDTV.

The results are showed in Table 1 followed by discussions below.

Country/ language	Institution	Name of the LO	Technology
Brazil / Portuguese	Federal Institute of Education, Science and Technology of Piauí (IFPI)	*Universo Interativo* [26]	Light Weigth User Interface Toolkit (LWUIT)
Spain/ English	University of Vigo	T-MAESTRO [27] and [28]	MHP, ADL SCORM
Brazil/ Portuguese	Federal University of Pernambuco (UFPE)	*Efeito Fotoelétrico* [29]	Mind maps
Brazil/ English	University of Campinas (UNICAMP)	Tests and Support Material [6]	MHP
Brazil/ Portuguese	Federal University of Rio Grande do Sul (UFRGS)	The Common Paper as as User Interface for DTV [30]	Short paper, not well specified
Spain/ English	University of Vigo	ATLAS [31]	MHP, SCORM, TV-Anytime
Brazil – Europe	Brazilian European Consortium for DTT Services	BEACON [32]	interoperability between the DVB and SBTVD-T
UK	Partnership between Kingston Interactive Television and the BBC	SOS Teacher [5]	

In the analysis of all full papers founded, there were selected 8 items for the review (examples of case studies) and 2 studies that are worth mentioning: [5] and [25].

The LO in [26] is a small application built using the Light Weight User Interface Toolkit (LWUIT) – a library, open source components of high-end graphics for the Java ME platform. It consists of a simulator of the solar system, where the interaction with students occurs through the simulation of gravity and travel among the planets. This LO has the intention to support the teaching of astronomy to students of 6th grade of Brazilian educational system.

This LO was being developed by the group of students (authors) on the date of publication of the paper. The next steps for this application, according to authors are: (1) using the application in real set-top-boxes to verify how it is portable; (2) testing the application with students of public and private schools to see how the application is accepted; and (3) make improvements in navigation and design of GUIs (Graphics User Interfaces) of the application [26].

The Department of Telematic Engineering of the University of Vigo has a working group in the iDTV Laboratory that have been working on the development of several tools to create DE contents for iDTV. The group published a lot about their studies and here are summarized 2 proposals: T-MAESTRO [27], [28] and ATLAS [31].

The other researches of the group are defining how to personalize the pedagogical contents for each TV viewer and how to allow the interaction between MHP and OSGi applications, which will promote the coordination of the iDTV and smart home worlds, financial supported by national and European research projects.

T-MAESTRO (T-learning Multimedia Adaptive Educational System based on Reassembling TV Objects) consists in LO self-adaptive for t-learning, designed to run on MHP (Multimedia Home Platform), which is the middleware developed for the European Digital TV. The educational material must meet the patterns of learning objects ADL SCORM and it communicates with an LMS (Learning Management System) through an API (Application Programming Interface). The main objective of this system is to adapt the content according to the profile of each user and show it on TV [27] and [28].

ATLAS [31] is a framework where the goal is to promote reuse and interoperability of LO. The LO developed for ATLAS are structured using as the standard complement of SCORM with TV-Anytime. The objects are distributed via broadcasting being available to the user through the MHP.

In [29] a description of developing a LO for the teaching of photoelectric effect is presented. The technology is well described in the paper, just as using mind maps tailored for digital TV without the use of a return channel. This simple LO runs in parallel to the main stream of the television program where the animations are adapted to the concept of Digital TV. The student navigates through the various levels of conceptual maps interacting and doing exercises.

Researchers from Electrical Engineering and Computer Engineering at the UNICAMP, using the platform MHP and a set-top box, developed a support environment for the education through television. During the activity, students watch a video and answer the existing questions on the screen. Moreover, this tool allows the students to search for more information on topics not covered in class [6].

In [30] educational materials printed on paper, in addition to content being studied, contains links to interactive LO to be shown on TV. These links are printed in bar code, when accessing a specific channel the content is downloaded to the set-top box automatically and will be available to the student at the time he wants. Through the reader barcode attached to the set-top box, the student can activate the interactive LO and enhance their studies.

The BEACON project is specific on Digital Terrestrial Television (DTT) carried out with the support of the European Commission [32]. It is being developed from 2007 to 2010 with three main objectives: deploy the services of t-learning related to promoting social inclusion in the state of Sao Paulo; investigate the interoperability between the European system (DVB) and SBTVD-T and study methods of the pedagogical use of Digital TV in DE.

This project initially has developed a preparatory course for the entrance exams in Universities based on using digital TV with the aim of providing knowledge to the poor. Another course was developed for teachers with the purpose of giving training to work with students with special needs. Reports on the studies are available in the website of the project, but it was not published the final report yet in our last search in June 2010 [32].

In the city of Kingston, located in the northeast of England, the company KIT (Kingston Interactive Television) in partnership with the BBC developed the SOS Teacher pilot project for promotion of services by involving local teachers. By accessing the services available, students are able to ask questions to a teacher by sending e-mail, through digital TV. In 30 minutes the teachers respond to questions directly on the TV channel. In addition, students can see the questions at any time by requesting video on demand [5].

The study made by Pjb Associates [5] is a comprehensive report that has the "state of art" of the issues concerning the development of TV-based interactive learning in the home. It was conducted from 1998-2002 and presented several case studies about iTV, mainly in UK and Europe, but has market researches of all world, as well as projected scenarios.

In the [25] there is specific research on education via television, with examples of interactive educational programs (especially from Spain) and the issues of educational elements to TV shows, There is another good "state of art" research like in [5], where the term t-learning is detailed and the history of education through the TV is addressed.

6. CONCLUSIONS

Lately, the systems of e-learning are widely used due to its ease reaching a growing number of people and also the low cost of operation. For people with less purchasing power, buying a computer with Internet access is often far from being a reality. On the other hand, the TV has become a media of communication and information that is inexpensive and available for virtually the entire population. Bringing e-learning for the TV (t-learning) makes digital inclusion a distinct possibility.

The planning and implementation of distance education courses based on the iDTV environment requires adjustments to the learning objects, which are small lessons or parts of a larger program of e-learning. Understanding the peculiarities of iDTV and adapt interactivity through the remote control is one of the key aspects for DE via digital TV to become attractive to prospective students. It is verified that the control of the content will be in the hands of the user because of interactive applications.

According to the results of published studies, some initiatives in the production of LOs tailored for iDTV were found, but it is perceived that the research, mainly in Brazil, is at the beginning of a long journey, for content, currently used primarily for computer, to be effectively used in television.

We highlight the research conducted by the University of Vigo in Spain, which has a research group consolidated in iDTV, being a source of practical cases of the MHP platform for interaction and may provide insight on applications and services that may be developed for the Ginga.

The BEACON project, which studies the interoperability between the European (DVB) and Brazilian (SBTVD-T), seems to be what will provide more significant results for the insertion of interactive educational programs in the Brazilian scenario. These are many small steps that should be given by developers and content producers to deploy the t-learning in Brazil.

However, such initiatives have been isolated and experimental, which reveals limitations, since none of them was tested on a large scale.

Future works could search for partnerships between research institutions and broadcasting companies that are already operating with digital transmission as a means to develop and offer content, even in pilot applications, to the potential consumers. It would be applied research that can bring practical results and test the effectiveness of DE programs through iDTV.

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