

# A Learning Oriented Technological Framework for iDTV

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## Abstract

*This paper proposes an open flexible learning oriented technological framework for interactive Digital TV (iDTV). The framework is designed to satisfy the pedagogical requirements and deal with the iDTV capabilities and constraints. The framework includes two main products: the authoring tool, where the course is prepared and the Course Multimedia Player, which is capable of presenting the course in an iDTV environment. The proposed approach has been validated in a simulation and real iDTV Set-Top Box (STB) environment.*

## 1. Introduction

Since the introduction of ICT, the learning industry has greatly widened the size of the market and the number of actors and tools. Within this context, Research and Development projects need to address real problems and propose viable solutions and products. This need is an essential requirement for developing technologies that can effectively support learning purposes and lead to the definition of viable products.

Within this continuing evolving context, interactive Digital Television (iDTV) offers new possibilities for learning through the technological enhancement of the traditional TV medium to create more engaging and effective learning activities.

The purpose of this paper is to present a learning-oriented technological framework for iDTV, which is capable of offering services aimed at increasing the learning opportunities for the general public, mainly at home.

In order to implement the complete concept (i.e. make sample courses run on TV) and make the user tests, that are expected to provide important feedback about the usability of the system and its effectiveness, it was decided to develop a fully functional MHP [1] prototype. This choice is due to the fact that MHP is the middleware supported by DVB, which is the reference choice of the European Union and is largely compatible with other means, such as IPTV and cable TV [2]. It is true that DVB is working on new specifications for terrestrial (even if nothing is public about possible new middleware). However, it is expected that at least a certain degree of compatibility will be preserved. In any case, the proposed services are based on Java, thus are quite portable themselves.

Moreover, DVB itself highlights that DVB-T (and thus its MHP middleware), despite some drawbacks and shortcomings, is still the suggested option for the analog-to-digital transition period [2]. In this view, this work proposes an MHP-based reference implementation in order to test with real users and publicly demonstrate the proposed platform-independent format to institutions and investors.

This paper is organized as follows: in section 2 the pedagogical requirements are presented while in section 3 the technological framework is described. The results are discussed in section 4, related work is presented in section 5 and finally section 6 concludes the paper.

## 2. Pedagogical Requirements

The first forms of learning with iDTV have been little more than modified or enhanced videoconferencing. Today, iDTV platforms for learning provide a big amount of audiovisual and educational contents to the

viewer through interactive services and content personalization.

In defining a t-learning pedagogy we consider a user (learner) centered design perspective and the analysis of the features of the medium to reduce the risk of implementing courses that are technically feasible but pedagogically inconsistent with medium and its audience.

The learner centered approach aims at considering and overcoming two fundamental drawbacks present in educational practices that instead of being solved by ICT technologies can be amplified by them:

1. The typical educational approach assumes a world of independent individuals who "acquire" knowledge according to universal principles.
2. The co-construction of knowledge in the learning process is relegated to pre-established paths that follow an abstraction-instantiation loop. Most of teaching is done through abstraction. The students are completely excluded from the possibility to produce institutionalized educational paths, even when the theory goes that proper understanding is achieved only by co-construction of knowledge.

iDTV is considered as the convergence of television and computer technologies by encompassing three important features typical of computer-based technologies [3]:

- Interactivity: The control of the whole activity and of the elements of a single activity can be placed into the hands of the potential consumer [4].
- Personalization: Use of technology and viewer information, to tailor interactive content to each individual viewer profile [5].
- Digitization: Technological advancements that allow better quality of sound and picture [6].

However, TV includes features that differentiate it from PCs. First of all, TV is usually watched by more than one person (co-viewing), and usually triggers social interactions that are very useful for a more effective experience and interiorization of the contents. Secondly, the logic of broadcasting to a wide population enables social mass mechanisms that typically enhance the impact of the broadcast program. In defining a t-learning pedagogy it is, thus, crucial to deal with an active learning model, the constraints imposed by the actual development of the technology and the nature of the allowed interactions.

In this context the challenge is to exploit the added value of providing an interactive learning environment and the potential of allowing people to access learning

activities and contents directly in their house, at distance, through media easy to access and simply to use.

This reflection produces a twofold vision that aims at balancing learning and teaching strategies:

1. Leave the control to the learner.
2. Guide the learner.

Thus, to draw a pedagogy for t-learning experiences two dimensions have to be explored and taken into account as the drivers of the design process:

- the context where learning happens and the behavior of learners in this environment;
- the specific features of the medium.

The interactivity, audio/video-based experiences, narrative learning environment and informal learning/edutainment are the key points that emerged from this exploration.

### 3. Technological framework

Based on the above pedagogical requirements, a technological framework has been designed and built in order to support an efficient development and deployment of t-learning applications. Such applications represent a novel educational iTV format, that can be applied in a variety of fields in education and not only.

The general philosophy of the approach involves:

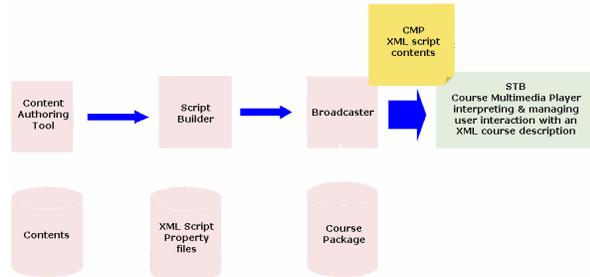
- A linear A/V stream (the traditional TV program, on which the user has no control)
- Non-linear interactive contents (on which the user has control)

This schema is realizable through existing TVs, equipped with STBs, thus reaching a wide share of population. Although internet connection (even not broadband) is not required, additional services included in the system are capable of exploiting it in order to enhance the user interaction and experience. On the other hand, non-linear Audio-Visual (A/V) stream contents would require (at least with present technologies) broadband connectivity, which is not supported by the majority of current TVs.

More specifically the framework involves two parts: the production side where the course is prepared with the aid of an authoring tool; and the client side where the course is presented to the viewer with the support of a course player software. The whole procedure is illustrated in figure 1.

From a pedagogical point of view, this schema involves an important role of the author, who defines the learning space and provides strong guidance by defining the A/V stream, the scheduling and the contents, and of the user, who has a certain freedom in exploring this knowledge space (e.g. deciding whether

to perform an interactive test/quiz/game or not, decide which branch of the course to follow). For any course's implementation, the author can decide the desired level of freedom/customization (e.g. by preparing contents for various categories, setting user-performance-based triggers for more information cards, quizzes, letting a number of parameters variable for personalization, etc.).



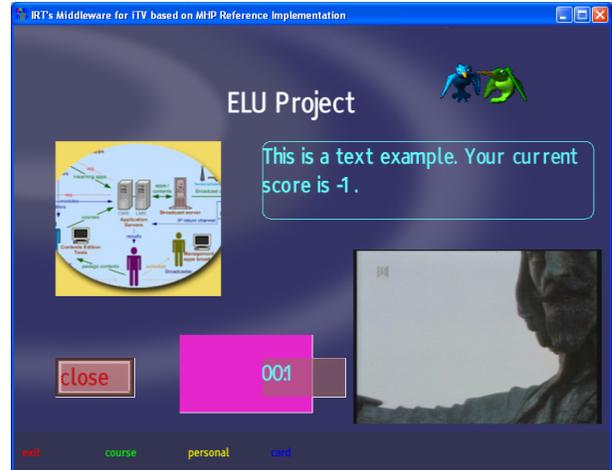
**Figure 1: Technological Framework**

The technological framework is based on the idea that the course consists of resources that can be presented at runtime by the proper course player software. Modularity, re-usability, customizability, flexibility, extensibility, homogeneity are the keywords of such an approach.

### 3.1. T-learning Course

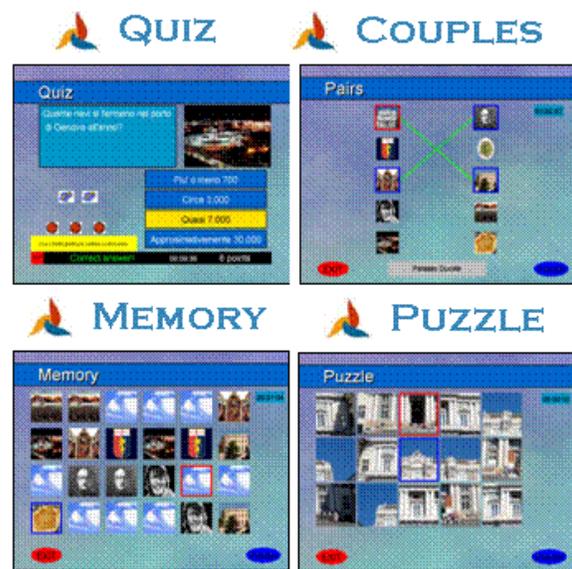
A t-learning course is considered to be composed of two main parts: the static and the dynamic part. The static includes a set of highly customizable multimedia educational units, which are called cards, while the dynamic defines the flow of the course in time by the different condition-based paths, the synchronization with the A/V stream and the interactions.

In the static part, each card provides one or more services, which are author-customized instances of service templates. Such services include: multimedia pages and presentations, interactive edutainment elements and support for ancillary devices. Such items can be presented at runtime by using specific MHP-java classes which read the property files that are created in the authoring tool. This means that several different instances of the same item can be presented with the support of the same classes that will read different property files at runtime. This is very important for the runtime environment of the STB as one of the major constraints is the limited bandwidth of the transmitted applications.



**Figure 2: Sample Multimedia page**

A multimedia page (Mpage) is the most common item that could be included in a card. It allows the free location static assets as titles, pictures, text zones and also interactive assets as buttons. The property file supports the customization and the personalization of the page including text fonts, text boxes size and location, etc. A sample Mpage including several interactive components such as: text without border, animated image, image, text inside rounded border area is illustrated in figure 2.



**Figure 3: Instances of Games**

Interactive edutainment elements cover various categories, such as arcade, adventure, puzzle and educational games. Quizzes, multiple-choice and

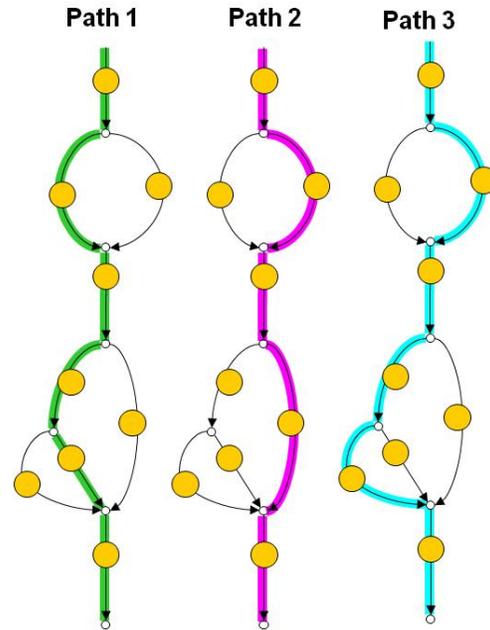
memory games could increase the interest of the viewer-learner supporting the concept of relaxed-learning that seems suited to TV. The games that can be included in a course are based on specific configurable templates and form an MHP-java class package, which is used for the runtime presentation. In figure 3, sample instances of Quiz, Couples, Memory and Puzzle games are illustrated.

Apart from the aforementioned items that can be included in a card, other services are also supported by the course's structure. Such services include the exploitation of a potential return channel (i.e. internet connection) for the on demand delivery of requested material (e.g. documents, maps, presentations etc.) that can be sent to the user's e-mail or fax.

The dynamic part of the course, which represents the actual flow of the cards (figure 4), is encoded in an XML script which is called "course script" and it is interpretable at runtime. This script includes the following information:

- Declaration and synchronization of the cards with the underlying iDTV A/V stream (thus directly enhancing the current TV program) with time stamp definition.
- Declaration of asynchronous cards which are accessible at any time during the course.
- Links to the corresponding property files of each card.
- Declaration of navigation bars, that consist of 4 sets of menus (one per each remote control's colored buttons) that provide the user access to additional functions (e.g. personalization services, more-in-depth info, helps, etc.).
- Condition-based flow control of the course. Such conditions are based on the real-time value of dynamic (e.g. score, status etc) and/or static personalization variables (e.g. age, sex, etc), that are tracked and managed by the system.
- Categorized flow of the course. Different user categories can be defined by the author either regarding the difficulty level (e.g hard, easy) or specifying different approaches according to the user's skills and the context of the course (e.g. history profile, architecture profile, etc).

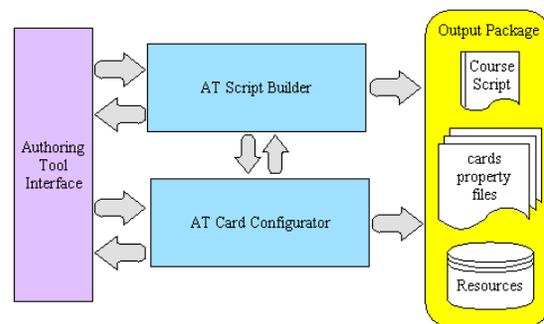
Both the static and dynamic parts of the course are realized in a package that contains the card resources (i.e. property files, multimedia objects) and the course script. This package is the actual outcome of the authoring tool and it is presentable in the iDTV by the Course Multimedia Player (CMP).



**Figure 4: Dynamic part of the Course. 3 different user categories are represented.**

### 3.2. The Authoring Tool

The AT is a visual development environment where the author is supported in the creation educational courses for iDTV. It consists mainly of two logical parts which are integrated in a common user interface: a) The script builder, which is the part for writing the course script (scheduling of the cards, definition of alternative course paths) that corresponds to the dynamic part of the course and b) The card configurator part for the creation and the configuration of the instances of the service templates (e.g. Edutainment Templates) which are included in the static part of the course. The architecture of the AT is illustrated in figure 5.



**Figure 5: Authoring Tool architecture**

The AT provides a clear graphical interface (figure 6, 7) which supports visual composition features as drag and drop, content previews and object designing. The tool provides a “WYSIWYG” environment where authors can focus on the contents and the logic of their course without having to concern about the internal structure and the constraints imposed by the XML script.

The concept of the tool is based on the creation of Learning Objects in a form of XML script and on the configuration of existing templates.

A Learning Object (LO) [7] can be defined as both the basic unit of a learning experience and as a small, atomic chunk of learning that can be reused in different context. In other words, the LO structure is actually an aggregation of items, which grant a customizable and flexible reuse.

Following this definition, and by adopting the LO model, it is possible to integrate several multimedia components and thus create educational material and content suitable for distribution through an iTV infrastructure. Thanks to this model, the content author can manage separately the various components, as well as the parameters that define their behaviour, and then generate in a simple way the final LO (course) in the form of a XML script.

The AT script builder (figure 6), which is dedicated to the definition of the user categories and the scheduling of the cards, provides authors with an intuitive way for defining events lists (temporal or logical) and consequent actions, with the support of personalization as well. Timeline bar proved an easy medium for content authors to use since it is more comprehensible comparing to event triggered-based flow charts. The tool handles the definition of all the supported operations/instructions by using an XSD schema in a “secure” mode, thus avoiding the risk for the author to generate invalid XML files.

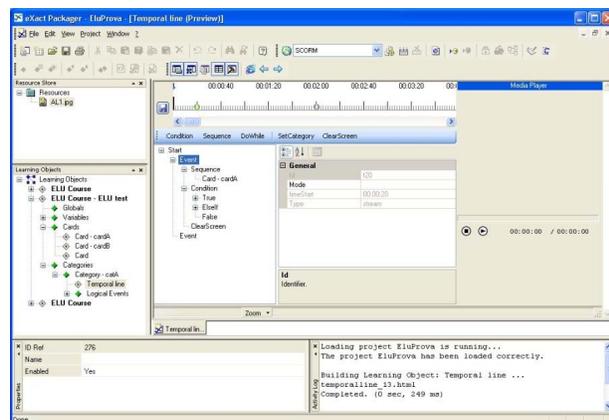


Figure 6: AT Script Builder

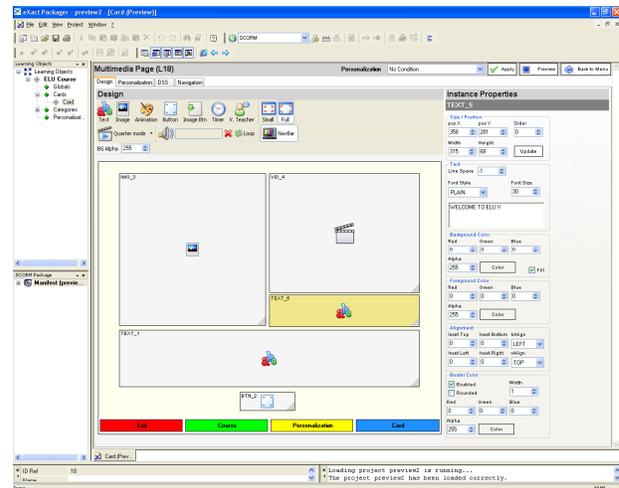


Figure 7: AT Card configurator

The AT card configurator (figure 7), which is responsible for the configuration of the cards provides a friendly environment where existing templates can be customized. These templates include Multimedia pages with images, buttons and text, multimedia presentations, delivery broker and edutainment templates, which can be configured appropriately in terms of appearance, fonts, score computation modalities, content etc., as described in a previous sub-section.

The tool supports two modalities of configuring a newly instantiated service: full configuration, which gives the author full access to all the configurable parameters of the service, and the Style configuration, where the graphics are pre-defined and the author has to insert the contents (e.g. questions and answers, images to be manipulated, graphs, etc.). The first approach is suitable for high customizable solutions, but may be time-consuming and addresses mostly to experienced authors, while the second approach is more efficient since the author can focus more on content than appearance while authoring process becomes more rapid and homogeneity insured.

In terms of compliance of the LO generated by the authoring tool and the existing - worldwide accepted - e-learning standards, it can be said that the SCORM specifications was adopted initially as a reference. Considering the peculiarities of an IDTV-based environment with respect to more “traditional” e-learning platforms, it became clear at a very early stage how SCORM cannot be used as it is to create t-learning courses and a more suitable structure has been conceived as explained in the previous sections. We can therefore say that the AT produces *SCORM-like* courses, without precisely following the official specification. This of course opens wide space for further discussions in the e-learning standardization

communities and, most probably, for an extension of existing specifications.

### 3.3. Course Multimedia Player

The CMP is the software module running on the STB which is able to present the course after processing the course package. It interprets the course script and subsequently creates the data structure through which it controls the scheduling of the cards, manages the interaction with the user and performs the synchronization with the A/V stream. It is constituted by a number of modules, including:

- 1) The *Course Script Parser* interprets the course script for the current course and accordingly creates the runtime data structure to manage the course.
- 2) The *Card Scheduler* manages the scheduling of the cards according to the synchronization rules, the defined user categories, and the personalization parameters and conditions.
- 3) The *Personalizer* provides two major personalization services: the first one concerns the scheduling of the cards, the second one the appearance, contents and functionalities provided by the Navigation Bar and the additional services (e.g. Edutainment Templates, Virtual Teacher, etc.). Personalization parameters include user features and preferences (also custom defined by the author for a specific course) and runtime performance.
- 4) The *Graphical Rendering Manager* is responsible for the graphical interface. The graphical user interface is composed of the Navigation Bar and the cards. A card typically contains one or more elements, such as Mpage and games. The MPage itself is a multimedia container that includes several components of different types (text rectangles, colour rectangles, images, buttons, animated images, sounds, timers) that can be positioned and configured on the screen as specified by the author (Fig. 2). The video stream can be shown as well on a portion of the screen, depending on the instantiated MPage's configuration. The Navigation Bar is displayed as a stripe at the bottom (or top) of the screen and is controlled by the user through the 4 iDTV remote control's colour buttons (red, green, yellow, blue). Each button provides access to a cluster (menu) of functionalities as personalization settings, choice of course categories, help and other advanced services.

## 4. Results

In order to validate the above framework and preview the courses that are being developed through the authoring tool an iDTV simulation environment

was employed. We have selected the MHP analyzer and simulator from IRT software.

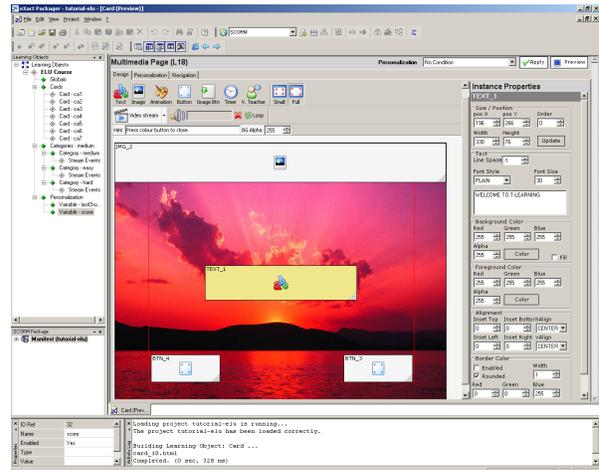


Figure 8: Configuring a Multimedia Page

During these tests it was possible to preview the static parts of the course independently from each other, and/or the complete course as a global flow.

Using the proposed authoring tool, six courses have been produced, dealing with the following topics: basic business, statistics for the Master in Business Administration, cultural heritage, mathematics for elementary schools, computers in a life-long learning perspective and driving school/road safety. The subjects of the courses were selected in order to cover a variety of different areas and address different target users. These courses have been designed by pedagogical experts from universities and institutes from 6 European countries.

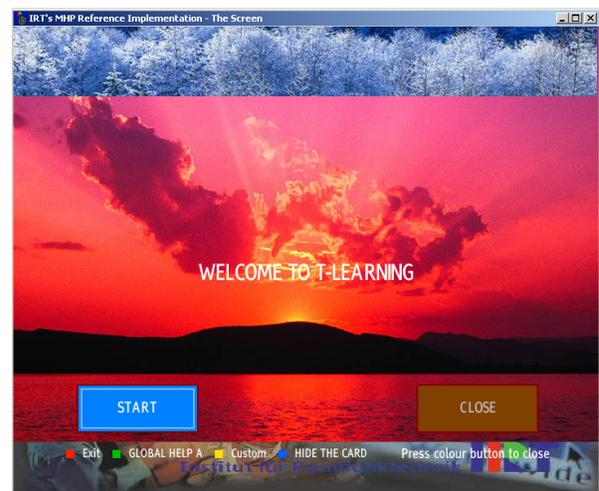


Figure 9: Preview in the simulator

As an elementary example, figure 8 shows the configuration of a card, which includes a multimedia page. Figure 9 shows the corresponding output in the simulation environment. In this case an image background was selected by the author, a text area and an image area were defined and finally two buttons were introduced to assist the navigation in the course.

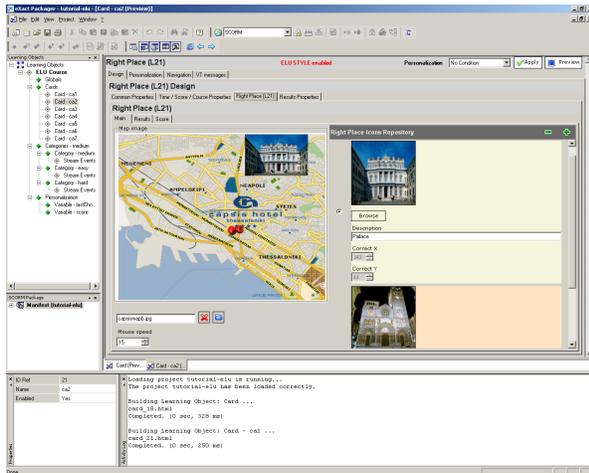


Figure 10: Configuring a RightPlace game

The card in figure 10 was configured by inserting a RightPlace game. Here, the author has inserted a map as a background and specified the location on the map of some points of interest (monuments in this case), whose representing images have to be put at their right place on the map by the player at runtime (Figure 11).



Figure 11: preview in the simulator

Figure 12 shows a snapshot from an interactive enhancement of the classic Disney Snow White movie. This is an example of a post-production enhancement, which limits the freedom of the iDTV designer since

the interactive part has to be superimposed to a material that has already been produced and optimized as a stand-alone product. This requires that the interactive enhancements be carefully designed and inserted so to meaningfully enhance the already defined pace of the movie, without compromising its quality and features.

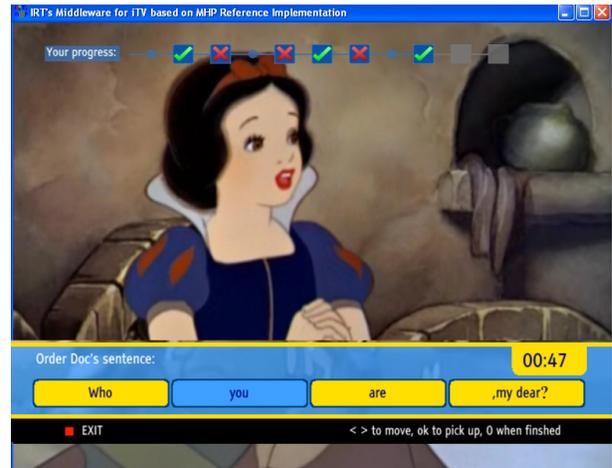


Figure 12: a synchronous quiz in the Snow White enhancement

## 5. Related Work

Although the research and development in iDTV-based t-learning is rather limited up to date, some interesting approaches have been presented.

An interesting approach was the technological framework for TV supported collaborative learning proposed in [8]. In this approach t-learning contents are created with appropriate tools and delivered however personalization was not applied and the fully automatic creation of the course was not supported. In a more recent work [9] a more general framework is presented with content creation based on XML structures and templates. Although this work has been an interesting basis it is still inadequate to deal with learning oriented content as it serves more general purposes. Furthermore the two aforementioned approaches haven't been tested thoroughly in iDTV or simulation environment, as no specific results are presented.

Considering the market approach, nowadays there are considerable tools available, both open source and commercial, like Composer [10] and Grins Pro Editor [11]. More specifically, the former is capable of creating content in NCL [12] language for Ginga middleware while the latter is a SMIL [13] editor. Such tools could have been used for the creation of pedagogical content due to their flexibility, however,

as they are not education-oriented, they would fail to satisfy the needs of pedagogues.

## 6. Conclusions

The purpose of this work is to explore how to enhance learning through interactive TV. The iDTV technology scenario (which includes modulation, coding, transmission medium, application middleware, etc.) is still fluid. And the landscape is complex, involving a variety of actors such industries, users and politics.

The presented approach to iDTV is evolutionary, rather than revolutionary. That is, it still considers the TV program as a linear AV stream that may be enhanced through simple interactivity. This is due to the still high popularity and pervasiveness of the TV as medium for supplying relaxed/informal information and stories. We still exploit the “authoritative” role of TV: a “story” is told (e.g. a documentary), knowledge is transmitted by an author. Along this path, the user can exploit interactivity to customize her/his own knowledge acquisition process by having more-in-depth information, immediately applying some concepts in concrete interactive cases, and face challenges suggested by the author.

One of the results of this approach has been the development of a set of products, that can be adapted and applied to several technologies/platforms (IPTV, cable, sat, etc.). In fact, we have tried to abstract key-aspects (TV interaction, education, relaxed context of use) that are independent of the platform, so we have developed a concept (CMP, AT, Course Script) that can be used for general linear-stream enhancement.

## 7. Acknowledgement

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