Designing the User Experience in iTV-based Interactive Learning Objects

Diogo S. Martins, Lílian S. Oliveira, Maria da Graça C. Pimentel
Universidade de São Paulo, São Carlos-SP, Brazil
{diogosm,lilianso,mgp}@icmc.usp.br

ABSTRACT

This paper reports the design of the user experience in EducaTV, an architecture for the association of value-added interactive content to educational TV programs. To properly tackle the unique user interface (UI) challenges posed by educational TV applications, EducaTV was designed through User-Centered Design (UCD) principles with extensive evaluation along the process. We report the main issues of access and findings obtained throughout the design process. Our findings revealed that iDTV applications must provide strategies to signalize interactive content without being obtrusive. Additionally, the context of the users must be taken into account, for instance by providing functionalities to enable collaborative interaction in learning groups, as well as mobilization affordances to encompass the different levels of technological literacy. Moreover, a recurrent issue that affected user experience was the proper synchronization of the live program with the interactive content.

Categories and Subject Descriptors

H.5 [**Information interfaces and presentation**]: User Interfaces—*Prototyping, User-centered design*

General Terms

Design, evaluation, multimedia

Keywords

Interactive TV, interface design, e-learning, distance education

1. INTRODUCTION

Considering that TV is a widely deployed technology, fighting the digital divide is seen as one of the potential benefits offered by interactive Digital TV (iDTV). Among the initiatives to provide digital inclusion, educational applications stand out as means to provide novel experiences in scenarios of distance education and e-learning. But such constrained devices impose limitations on user interaction.

Interaction with TVs is characterized by dependence on TV remotes (offering limited interactivity), shared resources (e.g. remotes) while watching programs in groups, multiple levels of attention (e.g. whether the TV is used as background sound or with full attention), interaction in situations of leisure and relaxation (e.g. living rooms), distance from the screen, among others [6]. Considering these challenges, this paper reports the EducaTV approach for authoring and execution of interactive educational multimedia documents in iDTV, enabling the association of value-added interactive content to educational programs. To properly tackle the unique user interface (UI) challenges posed by educational TV applications, EducaTV was designed through User-Centered Design (UCD) [11] principles with extensive evaluation along the process.

The EducaTV architecture is divided into back-end (which includes the content data model and the application logic) and front-end (user interface). Regarding the content model, materials are modeled as XML-based learning objects. To abstract the application logic and the interaction with learning objects, EducaTV comprises a MVC (Model, View, Controller) architecture to promote the portability and digital convergence of the solution. In this paper we report design issues of the architecture with emphasis in the front-end.

The usability of the front-end was extensively validated with case studies on the subject of informal and continuing education in defensive driving. Both user studies to gather requirements (e.g. interviews, questionnaires) and evaluations to assess usability (e.g. heuristic inspection, cognitive walkthrough, user test) were performed during the iterative design. Based on gathered requirements, different e-learning scenarios (e.g. government advertisement, individual learning at home and group learning at formation centers) were specified and used as framework to conduct evaluations of prototypes with real users and interaction designers.

Due to the lack of consolidated UI metaphors or design principles specially suited for iDTV, considerable challenges must be tackled when designing for this platform. Our evaluation results revealed that iDTV applications must provide strategies to signalize interactive content without being obtrusive. Additionally, the context of the users must be taken into account, for instance by providing functionalities to enable collaborative interaction in learning groups, as well as mobilization affordances to encompass the different levels of technological literacy. Moreover, a recurrent issue that affected user experience was the proper synchronization of the

SIGDOC 2010, September 27-29, 2010, S. Carlos, SP, Brazil

live program with the interactive content.

In the remaining of this paper, Section 2 reports the main theoretical issues related to this research. The motivation to conduct the research is clarified in Section 3. Section 4 reports the design of the user experience, with details on the user context, analysis, design and evaluation results. In Section 5 we discuss main findings of the design. Finally, Section 6 concludes this paper.

2. RELATED WORK

Many research efforts have been concerned with the development of solutions to provide ubiquitous access to e-learning experiences; these efforts aim at empowering users with technologies and tools to learn anytime, anywhere. Toward this goal, the availability of educational documents in iDTV enables learning experiences in situations of informal and continuing education, and these experiences can be intertwined and contextualized to the learner's daily life by the involvement of non-conventional access channels (such as iDTV), therefore specializing e-learning into t-learning [1, 8].

In a broad literature survey about t-learning, Chorianopoulos and Lekakos [7] advocate the advantages of iTV-based approaches to e-learning. In particular, they support the concept of edutainment (education as entertainment) based on the argument that user experiences with TV are historically related to entertainment-related activities. Accordingly, the design of learning experiences for iDTV preferably should be directed to informal learning via value-added interactive content associated with the main program. In fact, the focus on edutainment as value-added complement has been a recurrent issue, but while much focus has been directed on technological frameworks [18, 8, 13, 4] and specific applications [17, 20, 3], the interaction between the user and the educational applications has not been systematically thought about as much.

On the other hand, with the focus apart from educational applications, several research has been concerned with design guidance for iTV [19, 14, 21, 2, 5, 9]. In particular, the survey conducted by Chorianopoulos [6] highlights design principles recurrent in the literature, such as the focus on entertainment, support for social viewing behavior, relaxed navigation with remote controls and multiple levels of attention when watching TV. Kunert [12] develops an extensive catalog of UI design patterns for iTV (e.g. patterns for page layout, use of remote control buttons, text input and navigation), all of them designed and evaluated through user-centered design processes. Similar issues have been stressed by Collazos et al. [9] which develops some principles (e.g. simplicity, non-obtrusiveness to the main content, power of customization, etc.) and guidelines to conduct usability inspections on iTV apps. User-centered design of iTV applications were also tackled by Rice and Alm [19], but with research focus on accessibility issues of older adults.

Although our research provides a contribution to the landscape of t-learning systems, in this paper we shift the focus away from the inherent technical qualities of the system and emphasize usability issues in order to enable interactions as natural and intuitive as possible. Based on these considerations, our research is related both to the development of solutions to t-learning (specially the approaches which focus on the design of learning contents) and to the effective design of user experiences with iDTV applications.

3. MOTIVATION

EducaTV is a layered architecture to execute learning objects in iDTV. Learning objects in EducaTV are comprised of multimedia objects described in XML-based documents and can contain evaluation questions, contextual glossaries, as well as complementary materials, such as narrative audio, illustrative videos, among others. These contents are designed to be provided by a TV broadcaster as value-added interactive services to educational programs.

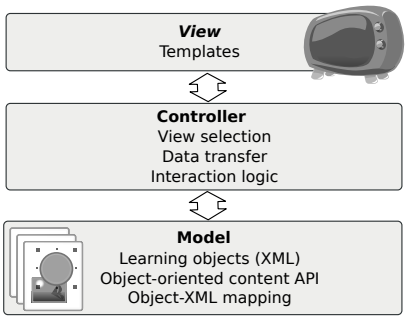

Figure 1: EducaTV architecture

The EducaTV architecture (Figure 1) follows the MVC (Model-View-Controller) design pattern for interactive applications. The model layer is concerned with the learning objects authored in XML as well as the mappings of the XML schema to an object-oriented API (*Application Programming Interface*). The objective of this API is to provide a programmatic approach to manipulate documents across the layers of the architecture. The controller layer selects views according to a predefined interaction logic (navigation model) and, concurrently, transfer data from the model to the view layer. On its turn, the view layer is composed of screen templates filled at runtime by the controller with data from the model layer. In this context, the model and controller layers represent the back-end of the architecture while the view layer represents the front-end. More details on architectural and implementation-related issues of the back-end were reported elsewhere [16].

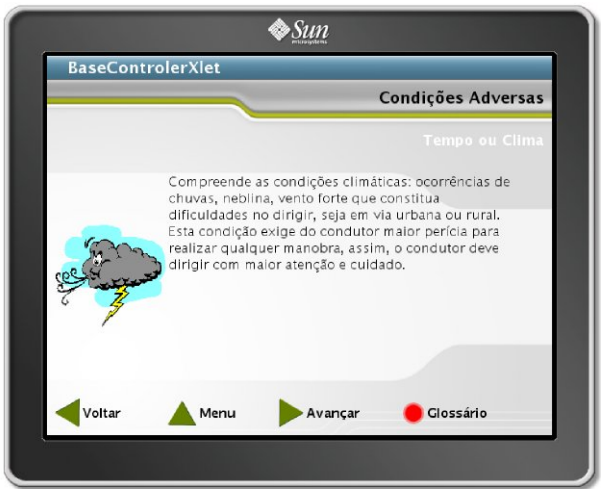

Figure 2: Sample of the first generation of the EducaTV UI

Initially, the EducaTV architecture was developed to satisfy two main requirements:

i) to provide a declarative approach to author interactive learning objects; and

ii) to develop a flexible execution environment to play the learning objects.

As we reported in previous work [16], these two requirements have been effectively met by the back-end of the architecture, but an open area for improvement was the better design of the user experience with the front-end.

The first generation of the EducaTV front-end (of which a sample screen is presented in Figure 2) was subject to an heuristic inspection which revealed several problems. The evaluators pointed out complicated navigability with remote controls, poor positioning status, weak notification of changes in sections of the content, and overall problems with layout and graphical design. Moreover, full screen presentation of the material on top of the TV program caused negative consequences because only the audio of the program could be followed while the interaction took place. This limitation in particular characterized weak linking among the contents and the TV program and provided poor support for group viewing, because while one user was interacting with the contents, the others could not watch the main video.

Based on lessons learned from those preliminary experiments, this paper reports the complete redesign of the EducaTV front-end from scratch. Therefore we started with the findings pointed out in the first usability inspection and extended the requirements in two main directions:

i) tackle interaction with the TV using non-conventional devices (e.g. cell phones); and

ii) support learning groups sharing the same TV in colocated activities.

It is worth stressing that the loose coupling among the layers in the MVC model enable the redesign of the front-end without substantial changes in the back-end. In the following sections we document the methods and procedures employed in the design and highlight main findings in terms of the user experience with EducaTV.

4. DESIGNING THE USER EXPERIENCE IN EDUCATV

According to Dix et al. [10] User-Centered Design (UCD) [11, 22] is an interative process divided in four broad phases:

i) *requirements*, in which the designer establishes what is wanted from the system by means of characterization of the users and their needs, usually by data collection (e.g. questionnaires, secondary research), observation (e.g. videotaping), among other methods;

ii) *analysis*, in which gathered requirements are analyzed and structured in a way so as to delineate key issues and provide proper communication to the later stages;

iii) *design*, during which requirements are materialized in prototypes which are evaluated to enforce their usability; and

iv) *implementation*, which occurs after several iterations of prototyping have lead to satisfaction of the core requirements.

The iterative nature of the process occurs among the analysis and design phases by means of prototyping sessions followed by evaluations to ensure that the pre-established usability criteria have been met.

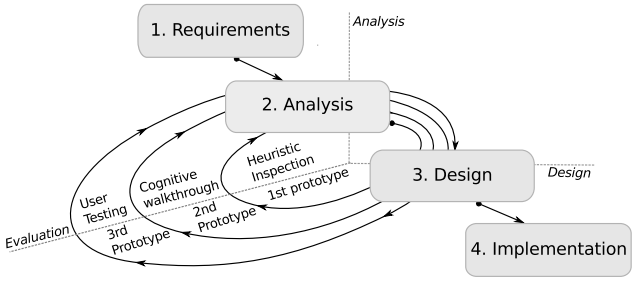

Figure 3: UCD process applied in EducaTV. Adapted from Dix et al. [10]

The user experience in EducaTV was designed following a UCD process comprising the activities depicted in Figure 3. In EducaTV, three prototype sessions and three evaluations were conducted to assess the usability of the system. After gathering requirements, in the first iteration of analysis a first prototype was built and evaluated through a heuristics inspection. Based on the results of this inspection, an improved prototype was designed and evaluated through a cognitive walkthrough inspection. Finally, a third prototype was made and tested with a representative sample of users. After all these steps, the results were considered satisfactory and the design was able to be implemented and deployed. In the following sections we describe procedures, methods and main results obtained throughout the process.

4.1 Requirements and context

The target audience of the instructional content is characterized by an adult population composed of motor vehicle drivers aged between 18 and 60 years old who are interested in recycling their knowledge in regard to defensive driving. The planned scenarios consisted in situations of corrective distance education programs concerning drivers who have been involved in traffic accidents and informative campaigns to reduce accidents.

In order to devise issues of technological literacy and acceptance of iDTV technology we performed a pilot study by means of a questionnaire applied to a sample of 21 subjects enrolled from the local community. All respondents were motor vehicle drivers in the specified age group, of which 67% were aged between 18 and 50 years old.

The core of the questions were targeted at analyzing the users acceptance to non conventional uses of TV. Figure 4 depicts that while many users feel comfortable to use remote controls, the majority of them notice shortcomings on these devices and desire alternative methods to perform the same operations. When asked if they would use a mobile as alternative device, the majority agreed but an expressive percentage was not certain if it would be desirable. With focus on the abilities to use mobile devices beyond making calls, 95% mentioned text messaging and 75% judged this task as easy. Other tasks mentioned were voice-initiated calls (24%), web

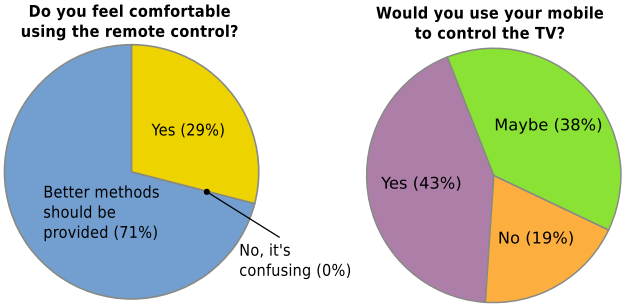

Figure 4: Selected results from the survey

browsing (19%) and miscellaneous uses (38%, e.g. alarms, take pictures and listen to music).

The questionnaire also included open-ended questions about what users expected from iDTV technology. The results revealed that the majority of the population between 35-50 years old expected enhancements to traditional uses of the TV, such as more channels, better quality of audio and video and easiness to record programs to watch later. Younger groups, aged between 18-35 years old, indicated non conventional enhancements such as access to multimedia content from the web, personalization (e.g. content recommendation, targeted advertisement) and digital convergence (e.g. watch TV on mobiles or employ mobiles to interact with the TV). All respondents that mentioned interactivity were in the 18-35 age group, and mentioned as desired interactive services the possibility to perform shopping and provide feedback to the broadcaster about the program (e.g. quizzes). When asked about the desire to obtain complementary information about the program being watched, around 90% answered that it would be a good enhancement.

Additionally to the questionnaire, pilot sessions of paper-based low-fidelity prototyping were conducted in order to clarify the pedagogical strategy to be used to introduce the concepts as well as to better delineate the overall dialog of the interface. These sessions occurred with designers experienced with e-learning and with the design of instructional material. A sample prototype developed in this phase in presented in Figure 5.

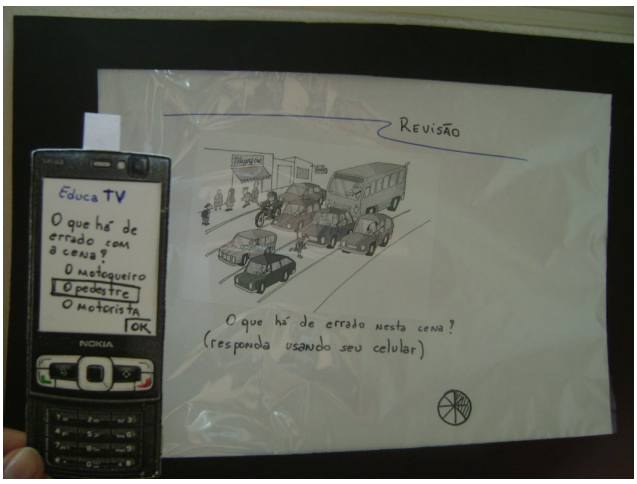

Figure 5: Paper-based low-fidelity prototype

From an instructional standpoint, a dialectic methodology was adopted to structure the contents of the courses, in which the learning experience is organized in three moments: *mobilization*, when triggering problems or situations (e.g. short-length games, quizzes) are presented to the learners to promote their engagement in the activities; *analysis*, in which learning material is analyzed in order to solve the proposed problem; and *synthesis*, after which a solution to the problem is proposed. During these phases short assessments may took place in order to properly sequence the content that is presented to the user. Additionally, the system should support both informal education at home via public TV channels and group-based distance learning in remote locations that do not count on specific formation centers. Based on these considerations, two interaction scenarios were designed which we present in Section 4.2.

4.2 Analysis

Considering the requirements gathered we developed two scenarios of corrective distance education programs concerning defensive driving: one of the scenarios considers individual and informal learning at home and the other considers formal group learning at distributed locations.

Scenario 1: Individual informal learning

This scenario considers the broadcast of defensive driving classes so as to enable informal and continuing education in the home environment. The user is watching the program alone at home and has the possibility of participating in interactive sessions with complementary material related to a topic being dealt with in the program. The interactive material can be associated to classes with specific purpose or with advertisements related to informative campaigns. From the standpoint of interactivity, during the program occurs non-obtrusive notifications of interactive content associated with the topic being presented in the program. When the user starts the interaction, the main video is rescaled to a reduced portion of the screen while a multimedia presentation illustrates the topic or some form of self-assessment via quiz. In particular, the assessment will enable the user to measure if the concepts presented in the program are being effectively learned.

0. user is watching the educational program
1. presenter announces interactive content and asks the user to press the red button. A red icon is notified in the bottom right corner of the screen
2. the user accepts the interaction
   2.1. interactive application is started, video region is reduced.
   2.2. user reads the instruction
   2.3. answer time counter is started
   2.4. user answers
      2.5. provide feedback according to the answer
3. close the application

plan 1: user accepts the interactivity, go through all steps
plan 2: user refuse interactivy, stay in task 0
plan 3: answer timeframe is expired in 2.3. Go to 2.5.

Figure 6: Sample task decomposition for scenario 1

In order to delineate the dialog of the prototypes and conduct the evaluations, task decompositions were authored encompassing the interactions achieved in this scenario. A sample task decomposition corresponding to interaction with a quiz is presented in Figure 6.

Scenario 2: Group-based formal learning

This scenario considers users attending distance learning classes in remote locations that do not count on formation centers for colocated instruction. In this context, live classes are broadcast and watched by geographically distributed groups. The users meet at a location that count on iDTV equipment that must be shared by the learning group, whose members have the possibility of interacting with the content in individual manner using their mobiles. The interactivity occurs by means of formative assessment during the class, in similar fashion as to the scenario of individual learning. The main distinguishing characteristic is that when the assessment is non-obtrusively notified, users could answer the questions individually using their mobiles (e.g. via Bluetooth communication) which have an specific mobile application pre-installed. The questions should be answered in the timeframe indicated in the TV. The iDTV equipment, in this scenario, centralizes the answers from the students that later can be summarized and socialized to the group. Additionally, if the meeting location count on a return channel, the user responses are forwarded to the studio where the classes are being broadcast. A sample task decomposition for this scenario, considering group interaction with a quiz is presented in Figure 7

0. user is watching the educational program
1. presenter announces interactive activity, notified by an interactivity icon
2. TV application starts
3. user starts application in his/her mobile
   3.1. user waits application to connect to the TV
   3.2. user reads the instruction
   3.3. answer time counter starts
   3.3. user answers the question in the mobile
   3.4. application provides feedback to the answer
4. mobile application sends the answers to the TV
5. close the application in the mobile and in the TV

plan 1: user accepts the interactivity, go through all steps
plan 2: user refuse interactivy, wait in task 1 until completion of the activity. Then go to task 5.
plan 3: answer time expires. Go to 3.4.

Figure 7: Sample task decomposition for scenario 2

Considering these scenarios, we iteratively developed prototypes which were refined with the results of each evaluation. In the following sections, we report such procedures.

4.3 Heuristic inspection

According to Nielsen and Molich [15], heuristic inspection is a discount usability method during which interaction experts detect problems in a user interface in reference to a predefined set of principles and heuristics. Heuristic evaluation is a low-cost and effective technique to enhance a user interface in prototyping stage while it presents the advantages of being widespread and simple to apply.

For this iteration of the process we built a paper-based medium-fidelity prototype for each of the scenarios presented in section 4.2 (Figure 8). Screens both for the TV interface and the mobile interface were developed. In the experiment the interfaces were evaluated considering nine heuristics:

1. visibility of system status;
2. match between system and real world;
3. user freedom and control;

Figure 8: Paper-based medium-fidelity prototypes evaluated in the heuristic inspection

4. consistency and standards;
5. error prevention;
6. recognition rather than recall;
7. efficiency and flexibility of use;
8. aesthetics and minimalistic design; and
9. recovery from errors.

It is worth stressing that, from the set of ten heuristics prescribed in the original method, in this project we applied only nine of them. In particular, we suppressed the heuristic of "help and documentation" since applications for iDTV, due to their inherent limitations of interaction, should emphasize easiness of learning so as users can build mental models of the application without consulting extensive documentation. In terms of procedures, the inspection was executed by three experts in interaction design which classified the problems as unimportant, cosmetic, simple, critical or catastrophic. After the specialists detected problems in the interface, their comments were grouped and ordered by priority and severity. Based on the analysis of the data, a plan of action was suggested to improve the interface.

The majority of the problems detected were classified as simple and a few as critical. The main problems detected were affecting the principles of responsiveness, personalization, consistency, familiarity and learnability. Considering responsiveness, it was suggested that users should be better informed about the time remaining to answer the questions and notified if the answers have been successfully submitted. A recurrent problem of personalization was that users that provide fast answers would have to wait the timeframe to elapse before returning to the full screen video. Consistency and familiarity were mainly related to icons used in the interface and graphical design of the timeticker clock. Finally, problems of learnability were related to the instructions of whether to start to interact with the mobile or pay attention to the TV. These problems were tackled in the second prototype whose evaluation results are presented in the next section.

4.4 Cognitive walkthrough

Cognitive walkthrough is an inspection technique to evaluate the usability of the system in respect to the tasks performed by the users of the interface. The focus of the technique is to identify problems that can impair the learnability of the system. Experts in interface design simulate typical

tasks performed by users while analyzing if the objectives of the tasks can be easily attained via the proposed interface. For this purpose, at first glance the context of the users are analyzed and typical tasks are defined. After that, the sequence of actions performed in the interface is established.

In this project, a preliminary pilot study was conducted with a single expert in order to assess if the protocol to conduct the inspection was feasible. The expert had experience with the design of applications for iDTV and interaction design. As a result of this pilot study, corrections were implemented in the original cognitive walkthrough procedure. The improved procedure was then applied considering a revised user interface (Figure 9) with five application developers.

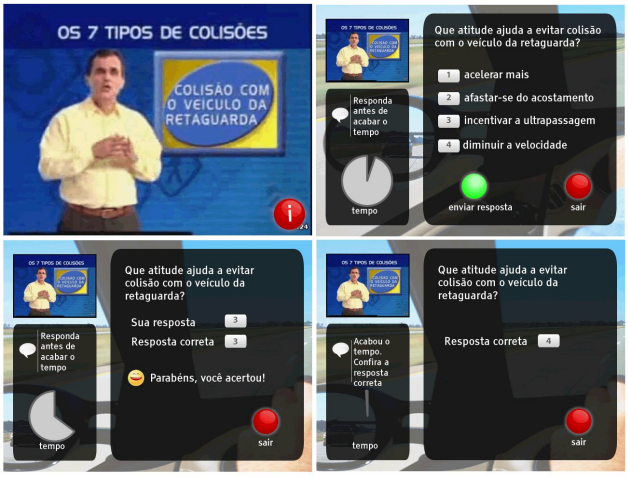

Figure 9: Sample screens from the prototype for the scenario of individual learning

The main detected problems that evaluators pointed out as impairments to the learnability of the system were related to predictability, familiarity and consistency, the majority of them detected in the mobile interface. About predictability, once again the timeticker clock presented problems, this time evaluators suggested numerical feedback about the time remaining; another problem related to predictability was the use of icons resembling mobile buttons when presenting the answers, situation that could lead the users to uselessly press the respective button. Familiarity was impacted by the use of technical terms in the dialog, such as "Connecting..." that should be replaced by "Loading questions...". Finally, generalizability problems were related to the graphical design of the buttons which could cause confusion with other functions of the mobiles. The proposed corrections were implemented in a third version of the prototypes which were evaluated with end users.

4.5 User testing

User testing applied to a prototype or end product is required to satisfy the functionalities of an interface and measure the impact of the design from the standpoint of the user. In this project we evaluated prototypes with real users using the techniques Wizard of Oz and Think Aloud. A sample of five users between 24-32 years old participated in the experiment, being two female users and 3 male users, all of them undergraduates. All of them had experience with computers and mobiles, but almost all of them had no experience with iTV.

Before each session, each user was informed about what the experiment was all about and received a brief expositive training on the operation of the system considering toy scenarios which were distinct from the scenarios of the experiment. Additionally, each user had a list of tasks to be accomplished in the interface. The evaluation sessions were recorded for later review. After each session, users answered questionnaires in which they should objectively evaluate core characteristics of the system. A refined prototype (Figure 10) was used in this experiment.

Figure 10: Sample screens for scenario 2. TV interface (top) and mobile interface (bottom)

Generally, the user interface was objectively well evaluated by the users, as they stated that committed few errors and were able to complete the tasks satisfactorily. On the other hand, through observation of the users interacting with the system, we noticed some problems.

Related to flexibility of interaction, we noticed that many users tried to use the directional keys of the mobile, while the prototype was supposed to react only to numerical keys. While interacting, some users had observability problems and missed some form of summary scoring their responses at the end of the quiz. Additionally, due to the colors of the "ok" and "cancel" commands resemble the buttons to start and end a call, some users have erroneously pressed these buttons, revealing a problem related to prevention of errors. But the most recurrent difficulty faced by the users was the lack of some form of preliminary guidance about how to initially operate the interface (e.g. how to start up the mobile application), problem that could be solved by providing short illustrative videos about these tasks.

5. FINDINGS AND RECOMMENDATIONS

A major lesson derived from our results is that interactions with restricted devices such as TVs must be as simple as possible in opposition to feature-rich and cluttered interfaces. If on one side simplicity limits the functionalities an iTV application may present (e.g. inputting text in these devices is still considered difficult) on the other side demands creativity to provide a required functionality without nega-

tively impacting simplicity. Furthermore the distance of the user from the screen and the reliance on a remote control demand the iTV applications be based on simple interaction models so as to promote effective usability. The adoption of simple design alternatives favors navigability, recovery from errors and learnability.

When considered that iTV applications are related to mass media, an important concern is that heterogeneity of users is hardly avoidable. In this direction, the context of the users must be taken into account in order to provide alternative interaction strategies. For instance, in our requirements we have to deal with group-based interaction while still supporting single-user interaction. So we had to design an alternative based on distributed devices (e.g. mobiles) with post-hoc synchronization without abandoning single-user interaction with remote controls. User context also affects other aspects of the interface such as the degree of technicalities in the language of the dialogs. Naturally, the designer must balance the risks of introducing alternative strategies. For instance, even though our design decision to introduce mobile devices has tackled the problem of group-based interaction, it introduced additional complexity, specially if we consider that many users stated they do not feel comfortable even with the remote control.

We also noticed that support for group-viewing behavior introduced additional problems, mainly related to synchronization. For instance, different users had different speeds to answer the questions of the quiz; so while some of them answered the questions very fast, others could not do it before the timeframe expired. Such problem was noticeable in our focus group, but could scale a lot more in the original scenario of distributed groups watching a live lecture. In summary, this example implies that designers should be aware that strong synchronization between the narrative of the application and the live program sometimes won't work as expected.

Concerning user guidance to operate the interface, our evaluations revealed us that while iTV interfaces must be as simple and intuitive as possible, users still need some guidance to operate the application. Although we disfavored the use of written help manuals in our design, the results recommend that some help must be provided to the user. Given the inherent multimedia nature of iTV, in future development we plan to provide guidance by means of short tutorial videos.

An important improvement in relation to the first generation of the EducaTV interface was that of the linking between the application and the program. Even though our design has already started with this improvement, in this opportunity we had the chance to assess that many of such problems presented in the first usability inspection have been satisfactorily solved by the new design. In fact, the presentation of a miniature of the main video, in opposition to a full screen approach, enforced the association among the interactive content and the TV program and improved group viewing behavior.

Finally, from a methodological standpoint, we noticed that user-centered design proved very effective in the development of a non-conventional user interface such as EducaTV's. In particular, the analysis of user context and iterative design were crucial to improve our prototype to satisfactory levels even if we initially lacked comprehensive guidelines to develop for the iTV medium.

6. CONCLUSIONS AND FUTURE WORK

In this paper we reported and discussed the user-centered design of an iTV-based application to provide t-learning services. We presented the main related research in the literature and made clear the motivation of this research as an improvement to an architecture in use. Requirements were gathered from users and specialists while iterative prototyping were applied with extensive evaluation along the process.

Our analysis of the results revealed some recommendations for the design of iTV applications. In particular, we detected that simplicity of the applications should be enforced. The context of the users must be taken into account by the availability of alternative strategies of interaction. Additionally, the designer must be aware of synchronization issues among the application and the live program. Even with simple applications, users sometimes need guidance and we advocate that for iTV applications a good strategy is to offer short video tutorials. Recommendations concerning the tight linking among the program and the application were also stated, mainly via availability of a reduced version of the main video while the user interacts. Last but not least, we concluded that user centered design proved very effective to develop non-conventional user interfaces specially when extensive design guidance is lacking.

As far as future work is concerned, we are currently conducting the implementation of a high-fidelity prototype of the new EducaTV interface. Still under user-centered design, this interface will be evaluated by end users before final deployment. Under this effort, we have still some open requirements to implement new functionalities in the EducaTV architecture, and we expect that being attentive to user-centered approaches will bring us additional insights into iTV interface design.

Acknowledgments. We thank FAPESP, CNPq, CAPES, FINEP and the MCT.

References

[1] P. Aarreniemi-Jokipelto. T-learning Model for Learning via Digital TV. In *16th EAEEIE conference*, 2005.

[2] A. Ahonen, L. Turkki, M. Saarijärvi, M. Lahti, and T. Virtanen. *Guidelines for Designing Easy-to-Use Interactive Television Services: Experiences from the ArviD Programme*, pages 207–223. IGI Global, 2007.

[3] K. Alic, M. Zajc, M. Tkalcic, U. Burnik, and J. Tasic. Development of interactive television t-learning course. In *MELECON 2008 - The 14th IEEE Mediterranean Electrotechnical Conference*, pages 139–144, 2008.

[4] F. Bellotti, S. Vrochidis, I. Tsampoulatidis, G. Bo, and L. Napoletano. A Learning Oriented Technological Framework for iDTV. In *2008 International Conference on Automated Solutions for Cross Media Content and Multi-Channel Distribution*, pages 79–86, 2008.

[5] S. Buchinger, S. Kriglstein, and H. Hlavacs. A comprehensive view on user studies: Survey and Open Issues for Mobile TV. In *Proceedings of the seventh european conference on European interactive television conference - EuroITV '09*, page 179, 2009.

[6] K. Chorianopoulos. User interface design principles for interactive television applications. *International Journal of Human-Computer Interaction*, 24(6):556–573, 2008.

[7] K. Chorianopoulos and G. Lekakos. Learn and play with interactive TV. *Computers in Entertainment*, 5 (2):4, Apr. 2007.

[8] F. Colace, M. De Santo, P. Ritrovato, and P. R. C. Mascambruno. From E-Learning to T-Learning. In *3rd International Conference on Information and Communication Technologies: From Theory to Applications*, pages 1–6, 2008.

[9] C. A. Collazos, C. Rusu, J. L. Arciniegas, and S. Roncagliolo. Designing and Evaluating Interactive Television from a Usability Perspective. In *Second International Conferences on Advances in Computer-Human Interactions*, pages 381–385, 2009.

[10] A. Dix, J. Finlay, and G. Abowd. *Human-computer interaction*. Prentice hall, 3rd edition, 2004.

[11] International Standards Organization. *ISO 13407. Human Centred Design Process for Interactive Systems*, 1999.

[12] T. Kunert. *User-Centered Interaction Design Patterns for Interactive Digital Television Applications (Human-Computer Interaction Series)*. Springer, 2009.

[13] M. R. Lopez, R. P. Diaz Redondo, A. F. Vilas, and J. J. Pazos Arias. Entercation: engaging viewers in education through TV. *Comput. Entertain.*, 5(2):7+, 2007.

[14] K. Y. Lu. *Interaction Design Principles for Interactive TV*. PhD thesis, Georgia Institute of Technology, 2005.

[15] J. Nielsen and R. Molich. Heuristic evaluation of user interfaces. In *VIII SIGCHI conference on Human factors in computing systems: Empowering people*, 1990.

[16] L. S. Oliveira, D. S. Martins, and M. G. C. Pimentel. Educatv: uma abordagem para execução de objetos de aprendizagem em tvdi compatível com ginga-j. In *SBIE 2009 - XX Simpósio Brasileiro de Informática na Educação*, volume 1, pages 1–10, November 2009.

[17] D. Pinto, J. Queiroz-Neto, and V. de Lucena. An engineering educational application developed for the brazilian digital tv system. In *Frontiers in Education Conference, 2008. FIE 2008. 38th Annual*, pages S2F–14 –S2F–19, 22-25 2008.

[18] A. Prata, N. Guimarães, and T. Chambel. Crossmedia personalized learning contexts. In *HT '10: Proceedings of the 21st ACM conference on Hypertext and hypermedia*, pages 305–306, 2010.

[19] M. Rice and N. Alm. Designing new interfaces for digital interactive television usable by older adults. *Computers in Entertainment*, 6(1):1, May 2008.

[20] D. T. Santos, D. T. do Vale, and L. G. P. Meloni. Digital tv and distance learning: Potentials and limitations. In *Frontiers in Education Conference, 36th Annual*, pages 1–6, March 2007.

[21] E. Tsekleves, R. Whitham, K. Kondo, and A. Hill. Bringing the television experience to other media in the home: An Ethnographic Study. In *Proceedings of the seventh european conference on European interactive television conference - EuroITV '09*, volume 21, page 201, Sept. 2009.

[22] A. Williams. User-centered design, activity-centered design, and goal-directed design: a review of three methods for designing web applications. In *Proceedings of the 27th ACM international conference on Design of communication - SIGDOC '09*, page 1, 2009.