Mobility in a Personalized and Flexible Video-based Transmedia Environment

Alcina Prata
Lasige, Faculty of Sciences
University of Lisbon
Lisbon, Portugal
alcina.prata@esce.ips.pt

Teresa Chambel
Lasige, Faculty of Sciences
University of Lisbon
Lisbon, Portugal
tc@di.fc.ul.pt

***Abstract* - This paper addresses the effective design of Transmedia environments to generate personalized additional video information from iTV, PC and mobile devices with a special focus on mobile devices. It presents the opportunities and challenges of the inclusion of mobile devices on this ubiquitous environment, turning it into a true "ecosystem of devices", designed and evaluated based on cognitive and affective aspects that influence the user experience. The system generates a Transmedia personalized web-based content, which provides extra information about users' selected topics of interest while watching a specific video. The web content may be generated and accessed through iTV, PC and mobile devices. Depending on the users needs, that web content may be viewed immediately or stored for latter view, individually or simultaneously, from these devices. An evaluation was carried out with a special focus on mobile devices, complementing previous evaluations with iTV and PC environments. The achieved results were very good considering that they helped rethink our mobile related assumptions and they showed that the integration of mobile devices on the environment was a success.**

Keywords - HCI; mobility; video; transmedia; iTV.

I. INTRODUCTION

The proliferation of new devices able to support human activities across a range of contextual settings [1] is one of the main motivations for media integration in what is designated as Crossmedia or Transmedia environments [2]. These environments, based in the integration and co-existence of various media technologies with an integrated and specific purpose are becoming increasingly popular due to their flexibility and mobility. They create new opportunities for the generalization of communicational practices, as those associated with formal and informal learning and information access, which are becoming more relevant considering the importance of lifelong learning [3] and the pervasive nature of media technologies and devices.

Video is a very rich medium to support learning, and TV, PC and, more recently, mobile devices are privileged ways to access it. Through structure and interaction, these devices can open the door to flexible environments that can access video and integrate it with different media, accessible from different devices, adequate to support different cognitive modes and learning processes in several contexts. In spite of their valuable potential to create rich and flexible environments, the design of these Transmedia systems faces some challenges that may affect their effective use. Some of the proposed systems failed because too much effort was put into technical details, leaving behind Transmedia conceptual aspects such as interaction and service design based on: cognitive processes, usability, user experience, contextualization, continuity, media affordances, and device characteristics.

Our main concern is to focus also and mainly on these aspects, while studying and understanding this emerging paradigm, where research has not been complete [1][4]. Our eiTV application has been designed and developed to illustrate our research. It was recently redesigned to support the use of videos other than TV shows on iTV, and the functionalities increased to match this more flexible perspective. Now we are redesigning it to fully support mobile devices and contexts of use. Running from iTV, PC and mobile devices, it provides users with the possibility to choose, from a video, usually watched in a more experiential cognitive mode (which allows us to perceive and react to events naturally), which topics they would want to know more about. They may also choose with which level of detail, and later decide when and where they would want to access those extra related contents, in a more reflective mode (the mode of thought), and with whom they would want to share them with, having the adequate support from the application in the different access contexts. The architecture and the main features available in iTV and PC contexts were already explored and described in previous publications [5][6][7], this paper will focus on the introduction of mobile devices and their specific functionalities and design in this Transmedia video-based context.

After this introduction, Section II includes a review of related work and concepts, Section III describes the design challenges of Transmedia applications and mobile devices in that context, Section IV presents the design decisions on the Transmedia eiTV mobile device module, evaluated in Section V. Finally, Section VI presents the conclusions and perspectives for future research and developments.

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II. RELATED WORK

This section addresses some of the more relevant related research studies in Transmedia environments that include mobile devices.

The TAMALLE project [8] developed a 'dual device system' for informal English language learning, based on watching iTV and selecting what to access later on mobile phones. This was an interesting system capable to accommodate different cognitive modes and different contexts of use, especially, if considering the mobile phone possibilities. Obrist et al. [9] developed a "6 key navigation model" and its interface for an electronic program guide running on the TV, PC and mobile phone. The different devices were not used in a complementary way since the intention was to test a similar interface, on three different devices. They have perceived that viewers prefer a reduced number of navigation keys and a unified UI with the same functionalities across devices. This confirmed our prototypes UI design last decisions. Newstream [10] provides extra information about what is being watched and related websites, using TV, PC and mobiles. Depending on the viewers' needs, that extra information may be viewed immediately, stored for later view or pushed to other device. Each device maintains awareness of each other and are able to: move interaction to the device that makes the most sense in a specific context, use several devices simultaneously, and use the mobile device as a remote to the TV and PC. Limitations include: the system relies almost exclusively on social networks to receive and share content, for interaction and dialogues; and the limited viewer direct influence on the new contents presented as extra information. Our work is more flexible in these concerns. 2BEON [11] is an iTV application which supports the communication between viewers, textually and in real time, while watching a specific program. It also allows viewers to see which of their contacts are online, which programs they are watching, and instant messaging on the iTV, demonstrated to be important to give viewers a sense of presence. Currently called WeOnTV, it is being implemented with smart-phones as "secondary input devices", soon to be distributed by one of the most popular Portuguese TV cable companies. This work demonstrates the importance of sharing information with viewers' contacts about what they are watching on TV, which supports our own decision of including a sharing functionality in eiTV.

III. DESIGN CHALLENGES

This section describes the central aspects, cognitive and affective, that need to be considered to effectively design Transmedia services and interfaces, with a special focus on the design challenges associated with video and mobile devices.

A. Transmedia Design Challenges

Media and Cognition: Norman's view [12] defines two fundamental cognitive modes. The experiential mode allows us to perceive and react to events naturally and without much effort, while the reflective mode is the one "of thought and decision making". Both are important in human cognition, but require different technological support, and the medium affects the way we interpret and use the message and its impact on us. For example, TV and video are typically watched in an experiential mode, but learning strongly relies on reflection. A successful integration of media should have into account what each medium and device is most suited for in each context of use, augmenting and complementing their capabilities in a flexible combination.

Transmedia Interaction, Conceptual Model and User Experience: the main challenges of Transmedia interaction design described by [13] include: consistency, interoperability, and technological literacy needed for the different devices. The conceptual model, how the software will look like and act, is also a very important aspect, since several interaction scenarios and contexts are involved [14]. The quality of the interaction cannot be measured only by the quality of its parts, but as a whole. In this context, the user experience (UX) may be evaluated through how well it supports the synergic use of each medium and the different kinds of affordances involved, also understanding what makes the user pass the current medium boundaries to use other media as well. According to [15], the UX may involve the isolated perception of the medium (distributed), one of the biggest barriers to its efficient use and adoption, or the perception of the system as a whole unity (coherent). According to [16], the UX evaluation methods and measures relevant, when ubiquitous TV is involved, are: physiological data; data mining, log files, observation, case studies, lab experiments, experience sampling method, probes, diaries, interviews, surveys and focus groups. The combination of methods to use depends on each specific case.

Supporting Transmedia HCI: In this context, the migration of tasks is supported via Transmedia usability and continuity, influencing on how well and smoothly users' skills and experiences are transferred across the different devices [17]. The consistent look and feel across media is an important requirement, even if it should not limit the goal of having each medium doing what it is most suited for and extending its characteristics (synergic use) [18].

Designing for Different Devices and Contexts of Use: Transmedia design involves designing interfaces for different devices. To understand the devices, and have each device doing what it is most suited for, the best approach is usually to study each particular situation, including device characteristics and cognitive and affective aspects associated to its use: why people use them, in which mode, compare them, etc., and the design guidelines for each device [6] followed by an adequate combination.

B. Mobile Devices Design Challenges

Interactive systems design has always been a hard task considering the diversity of factors that were involved and thus requiring the designer's attention, ranging from the final users needs to the context in which the solution is going to be used. More recently, the appearance of mobile

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and ubiquitous computing supported through different and new devices, and as in our particular case as part of a Transmedia application, contributed to a substantial increase of opportunities and challenges associated with the design process for these new devices.

Due to the specific characteristics of mobile devices, namely, their ubiquitous and permanent nature, small dimensions, several interaction modalities, the multiplicity of possible contexts of use, these devices interfaces are becoming extremely hard to design, but nevertheless very desirable in many contexts, and in particular in our application, due to their flexibility, mobility and location awareness.

As to the main challenges of mobile devices design, they are spread through the design process phases [19]:
1) *Analysis and requirements recoil:* on mobile scenarios where the use of the mobile device or application is constantly based on mutational contexts, where users may be walking and passing through different places and environments, the recoil of requirements is a difficult task and needs a specific approach;
2) *Prototyping:* prototyping techniques that support the construction and evaluation of prototypes in realistic scenarios is needed. In general terms, all components (device prototype and UI prototype) must be as faithful to the original as possible;
3) *Evaluation:* Recent research experiences suggest that given their intensive and pervasive use, mobile devices and correspondent applications should be evaluated on multiple and realistic settings [20]. In low-fidelity prototypes, the presence of the designer is usually required to act as the system, besides gathering usage information or detecting usability issues. Although far from a perfect solution, this evaluation approach (called wizard-of-oz), has been used successfully in several studies.

There are also design guidelines for mobile devices that we took into account. For example, Brewster's [21] set of guidelines to overcome the limited screen space, Kar et al. [22] guidelines about the system's usability, Sánchez et al [23] navigational hints to the construction of mobile web pages, and Apple [24] guidelines for SmartPhones.

IV. MOBILE DEVICES DESIGN IN EITV

This Section presents main functionalities and design options concerning mobile devices in the eiTV Transmedia system, in response to the challenges identified in Section III.

A. Mobile Devices Design Process

As stated by several authors, when designing applications and interfaces to mobile devices, the design and development process should be transported out of the laboratory [19], which was exactly what we did, along with taking into account the design challenges and guidelines addressed in Section III, in addition to traditional design guidelines in User-Centered Design methodologies. The specific mobile device challenges identified in Section III were addressed as follows:

In the Analysis and requirements recoil phase: It was decided to pay attention to the user behaviour changes according to the surrounding environment, the variables that trigger the changes and how they affect usability. For this, we used [19]: contextual scenarios, scenario transitions, and scenario variables (location and settings; movement and posture; workloads distractions and activities; devices and usages; users and personas). *In Prototyping*: we separated the physical prototype (the device) and the GUI prototype while building a realistic graphical UI in the low-fidelity (or mixed-fidelity, due to increased realism) prototypes. A real Smatphone was used and the GUI was designed on power point and printed in a colour laser printer, with the real screen size. All functionalities were designed in breadth and depth, and the designed interaction is very close to the final product. The *evaluation* is described in Section V.

B. Mobile Devices Functionalities

In the mobile devices, the central functionalities of the eiTV system are present: Create, Search, Share and Profile. These functionalities are available: at the 'departure point', which occurs while watching the video and generating the web content, and at the 'arrival point', when accessing/editing/etc. the generated web content. Although these functionalities allow the same actions as on iTV and PCs, they were not provided exactly in the same way, considering the different devices characteristics. To briefly remind these central functionalities: Create allows users to watch videos and select topics of interest to create further information; the Search functionality searches videos based on different criteria and allows to watch them, and edit the associated generated web content if there is one; the Share functionality allows sharing the generated web content, or retrieved video, with user's contacts; and the User Profile contains personal data in order to personalize the generated web contents.

In order to have each device doing what it is most suited for, contexts of use, device characteristics and cognitive and affective aspects associated to its use were studied. In what concerns to *specific mobile devices functionalities*, after this study, the following were made available:
1) *Great flexibility and mobility* (use it everywhere, anytime, anyway): when using the TV, the scroll is not an option, but that does not happen when using the other devices; contrary to TV and PC, mobile devices may be used everywhere, even when users are standing up, mining that any extra time may be used (if waiting for a medical appointment, in a bus queue, while in the train, etc);
2) *Location-based search using the GPS functionality*: the search functionality allows users to search videos related to their current location. As an example, when near the liberty statue the user may use this functionality to search, from its own system and the internet, videos related to that specific spot (this type of video files need to be inserted when using iTV or PC);

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3) *Add immediately, or latter, shot pictures or videos,* that may be *related,* to the video being watched, as additional information to the web content or, instead, really integrated as part of the web content.

C. Mobile Devices Design Options

As part of a larger Transmedia system, the design challenges identified in Section III were considered in the mobile devices design module. As to the cognition modes, all functionalities (central or specific to mobile contexts) were designed to accommodate users' changes in cognition modes, attention levels, and different levels of technological literacy or preferences. Namely: they may be more or less intrusive of the video watching experience, designed with 3 different information levels (ranging from less to more intrusive and informational), prepared to be viewed immediately or latter, overlaid or embedded onscreen, etc; if viewers turn off the device when in the middle of generating a web content, all the selected topics, will be stored and the web content will be generated; the user has a simplified navigation layout that takes advantage of the typical smartphones navigation characteristics as the scroll bar, tactile screen, etc. Thus, a simplified interface, when compared to the other devices (PC and iTV), was possible. Nevertheless different levels of intrusion were made available; on the search functionality, a specific location may be inserted through text or through the GPS of the mobile device; shot pictures or videos (stored or capture at that time) may be inserted as additional information to a web content at any moment.

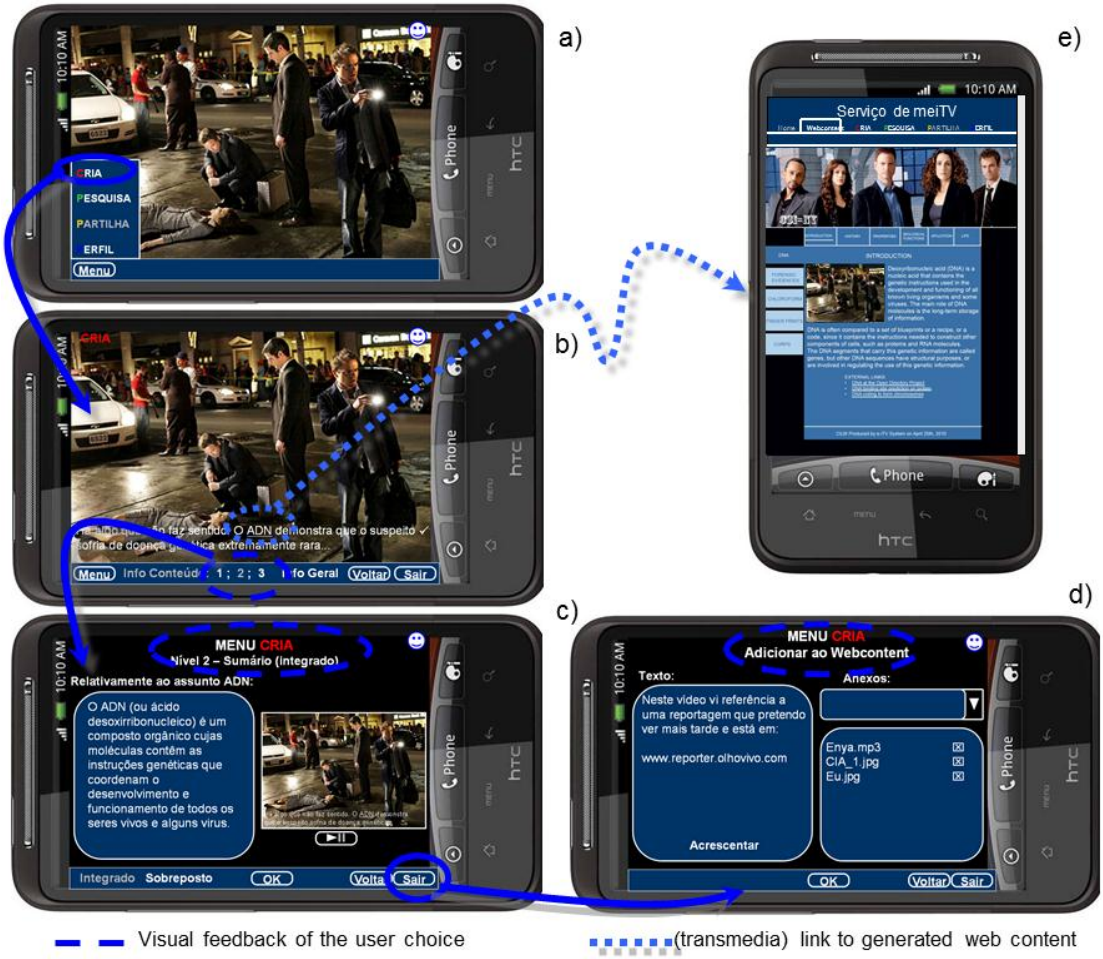

Figure 1. eiTV Mobile Interface *Create* functionality (a); topics selection interface with the information level 2 activated (b); aditional information immediately presented when a topic is selected by the user and the information level 2 is activated (c); interface to the addition of files captured on the moment to the web content being created (d); interface of the generated web content, based on the users selected topics (b-e)

Consistency in UX and the perception of the system as a whole coherent unity independently of the device being used was also a priority. In spite of having considered the mobile device characteristics and contexts of use in the design, towards a more simplified design, we decided to keep a coherent layout in terms of colours, symbols and other graphic elements, as navigational buttons, in order to better contextualize users, give them a sense of unity in their UX and to allow a smooth transition among media and devices. This way, it was possible to provide users with a sense of

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sequence and continuity, respect the context of use and be consistent in terms of look and feel and navigational options in all the devices, and to help the perception of the application as a unity. Users are aware that they may access their eiTV application through different devices whenever they create web contents, helping to conceptually understand the system as an 'ecosystem of devices'. An example of the resulting mobile module design interface is presented in Figure 1. Considering that it is the main focus of this paper, the presented interactions (Figure 1) are exclusively from mobile devices. However, these interaction proposal was already developed and tested on the other eiTV devices (iTV and PC), obviously taking into account these devices specific characteristics.

V. EVALUATION

The UX evaluation methods and measures considered relevant for this specific case as a preliminary evaluation were: observation, case studies, lab experiments, experience sampling method, interviews, surveys and focus groups.

The evaluation process started with a demonstration of the last tested high fidelity prototype on a PC, in order to remind users and to create a sense of unity of the whole application. Then, users were asked to perform tasks that allowed using all the eiTV functionalities (central and also mobile specific ones, already described in Section III), designed for mobile devices, through the prototype in three different contextual scenarios with transitions between them. Users started using the prototype standing up at the end of the bar queue (similar to other public queues), after that, they went to the library that, although surrounded by people, is a quiet place (context similar to a medical clinic waiting room) and they finally ended the prototype use in the school backyard seated in a relaxing place. Note that, in this last context, the luminosity conditions changed when going from the building interior to the exterior. The interaction with the GUI low(mixed)-fidelity prototype occurred via the wizard-of-oz technique to provide us with feedback at an early stage of development of the mobile prototypes without too much initial investment. It is important to mention that the evaluation process took place in real contexts of use, one of the most important factors to consider when testing mobile devices applications.

Finally, they were asked to fill a questionnaire and were interviewed. The questionnaire was based on the USE questionnaire (usefulness, satisfaction and ease of use) [26]; the NASA TLX questionnaire (cognitive overload) [27]; and usability heuristics. There were 15 participants, ranging from 20 to 45 years old, which were grouped into 3 evaluation groups: 5 students with high technological literacy; 5 students with medium technological literacy and 5 persons with poor technological literacy. Their technological literacy categorization was possible via the use of a questionnaire with question as: do you use Internet? e-mail? facebook? How many hours a day do you use the Internet? From which devices? Do you have a smartphone? Which functionalities do you use on your smartphone? Amongst many other specific questions. The participants were the same that had participated in the last prototypes evaluation, to maintain a conceptual idea of the whole application, and allowing to ask for comparisons, without making the tests with the other devices again. Results are presented next.

At both the 'departure interface' (generate the web content through mobile device), and 'arrival interface' (access that web content) as presented in tables I and II: The mobile interface was considered easier to learn than the TV interface, but the TV interface was considered more pleasant visually and better designed. In terms of information level, more users preferred level 1 information (the less intrusive and less informational) than on TV. This result stresses an increase in users preference to select additional info to access later on when they are watching video on the move with a mobile, when compared with TV, where users already prefer this option not to interrupt the more experiental mode of watching videos especially on TV.

TABLE I. EVALUATION OF EITV OVERALL DEPARTURE AND ARRIVAL INTERFACES

eiTV Transmedia System		Easy to learn	Visually pleasant	Well designed	Could be better
Departure Interface:	TV	73%	87%	73%	87%
	Mobile	93%	73%	60%	87%
Arrival Interface:	PC	87%	87%	80%	67%
	Mobile	93%	80%	73%	87%

TABLE II. EVALUATION OF EITV OVERALL DEPARTURE AND ARRIVAL INTERFACES (INFORMATION LEVELS)

eiTV Transmedia System		Most used information level		
		1	2	3
Departure Interface:	TV	47%	40%	13%
	Mobile	60%	27%	13%
Arrival Interface:	PC	Not tested	Not tested	Not tested
	Mobile	Not tested	Not tested	Not tested

The central functionalities: Create, Search, Share and Profile (see tables III and IV) were considered more useful than in the previous tests (from iTV to PC). As to the most important ones in the context of the application (Create and Search) they were also considered more interesting. As to specific actions inherent to the use of mobile devices: all users appreciated the idea of mobility (93%), the possibility to use GPS in location-based searches (67%), and the possibility to add pictures and videos to the web content, at that particular moment or later, both related and unrelated to the video being watched (87%). Most functionalities were considered more difficult to use, if considering the smaller screen size and font (67%) and mixed fidelity prototypes, but easier (80%) if considering the interaction mode (tactile screen versus mouse and remote). These aspects, along with having the access to the web content in the same device that created it, also influenced (decreased) the perceived need for contextualization at arrival. For more accurate results on these aspects, a prototype with video actually playing is important.

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TABLE III. EVALUATION OF THE CREATE AND SEARCH FUNCTIONALITIES FROM TV AND MOBILE DEPARTURE INTERFACES

Characteristics:	Create		Search	
	TV	Mobile	TV	Mobile
Interesting	80%	93%	73%	100%
Ease to use	80%	47%	77%	40%
Useful	87%	100%	87%	93%

TABLE IV. EVALUATION OF THE SHARE AND PROFILE FUNCTIONALITIES FROM TV AND MOBILE DEPARTURE INTERFACES

Characteristics:	Share		Profile	
	TV	Mobile	TV	Mobile
Interesting	73%	73%	60%	60%
Ease to use	73%	60%	47%	80%
Useful	80%	87%	53%	67%

It is important to mention that in spite the use of a mixed fidelity prototype the intention of transmitting a sense of unity was achieved: 87% of the users referred that they immediately felt "inside" the same application, in spite of using a different device (table V).

TABLE V. EVALUATION OF CONTEXTUALIZATION FROM DEPARTURE TO ARRIVAL INTERFACES

	Sense unity	Context with video or image need	Context with video playing need
PC	80%	93%	73%
Mobile	87%	87%	60%

As a whole (table VI), the transmedia application with the mobile devices was considered: more useful, easier to use, easier to learn, and more users would like to have it and would recommend it to a friend, when compared to having only iTV and PCs, with high percentages (87% and 93%).

TABLE VI. OVERALL EVALUATION OF THE WHOLE EITV TRANSMEDIA APPLICATION

Whole Application	Useful	Easy to use	Easy to learn	Like to have	Recommend
TV & PC	87%	73%	67%	87%	80%
TV&PC&Mobile	93%	87%	87%	93%	93%

In general, there was no substantial difference of opinion amongst the 3 groups. Nevertheless, it was possible to observe that the group with poor technological literacy, in general, took more time to accomplish the proposed tasks and asked more questions. However, like the other 2 groups, they all made it and the enthusiasm was the same. Interesting to note, no considerable differences were detected between the group with high technological literacy and the group with medium technological literacy. This may be explained by the fact that they add already participated on previous evaluations of the eiTV so they are probably becoming more familiar with it. Thus, and in order to overcame this situation, after concluding the high fidelity prototypes, these groups and completely new ones will be used for evaluation purposes.

VI. CONCLUSIONS AND FUTURE WORK

The evaluation results were encouraging. In many aspects, the increased functionalities and flexibility inherent to the mobile context were perceived as useful and an added value in this Transmedia context (e.g., location-based search). Some design options allowed to accommodate the users cognitive mode changes (e.g., information levels), and the prototypes where designed and tested in realistic mobile scenarios and contexts of use. In general the results showed that the integration of the mobile devices in the eiTV environment was a success. The use of a mixed fidelity prototype was a good option in a preliminary phase, considering that it helped detecting most significant usability problems, test ideas and it provided us with good clues for future developments, with a reasonably low investment. Based on the obtained feedback, some aspects need to be revised in terms of the size restrictions in the interface, and next evaluations should take place with high-fidelity prototypes to increase the realism in media access, in addition to the already realistic mobile contexts. Considering the design framework followed, the trends in the use of multiple devices, and the results of this and previous studies, we have reasons to believe that our goal for this Transmedia context is worth pursuing and that we can achieve quite good results with all the devices in different scenarios.

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