Overview of UI Patterns on Mobile Platform
for Educational Applications

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Abstract. Software development is currently experiencing significant growth, and the need to improve user interfaces is an important factor. Given this situation, interface design patterns have emerged as a new means of improving the user experience. However, their use has not been adequately studied for use in specific domains such as education. For this reason, it is necessary to analyze design patterns for mobile applications in order to determine the best design patterns for improving the quality and usefulness of applications, more specifically in educational environments. Having this into account, this paper presents an analysis and classification of mobile UI patterns in order to understand their applicability for the educational domain. We present a comparative table of mobile UI patterns implemented on several platforms.

Keywords: User interface, mobile platforms, educational applications.

1 Introduction

New technologies and programming styles are currently promoting the development of adaptive user interfaces for different types of software systems. However, if the concepts established by the Human-Computer Interaction (HCI), which are based on the concepts of utility and usability, are not taken into account, these interfaces do not ensure user satisfaction. HCI is intended to increase the productivity and safety of both the system and the user [1].

User interfaces are a crucial factor in ensuring the success of an application [2], [3], not only in a commercial and promotional point of view, but also in terms of acceptance by the end user, as well as ensuring the software achieves its objective of meeting a need or solving a problem. In educational applications, the aforementioned concepts represent an exceedingly important means of ensuring better teaching-learning processes through the use of technology. In this sense, HCI allows the successful development of graphic user interfaces. Sometimes the applications are developed for specific users, and in this case it is necessary to determine the type of interface to develop.

Mobile applications have grown considerably and have been faced with the challenge of adapting the user interface design for different devices such as iPads,

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Microsoft's Surface Tablet and Android tablets, to mention but a few, taking into account the mobile device constraints such as screen size, keyboard type, screen resolution, processing power, storage space and communication capabilities. Mobile devices offer higher independence in terms of location and time when compared to web-based education processes accessed via computers. In this sense, there is a necessity to define interface standards for these kinds of applications. However, interface design patterns for mobile devices have not yet been sufficiently studied in terms of their use for specific domains such as education. For this reason, it is necessary to analyze existing mobile design patterns in order to get more out of mobile devices.

This paper is organized as follows: Section 2 presents recent advances in state-of-the-art mobile UI design patterns. Section 3 describes the analysis of the interface design patterns for mobile devices. Section 4 presents the mobile platforms that were selected for this work. Section 5 presents a case study that implements the design patterns identified on mobile platforms, as well as shows the results of the evaluation using frameworks multi-device and the discussion of the evaluation results. Section 6 describes the future directions to be taken. Finally, the conclusions are presented in Section 7.

2 State of the art

In recent years, several studies have been proposed with the aim of improving the development of user interfaces. Most of these have been focused on the use of UI patterns in a variety of contexts. However, the use of design patterns in educational contexts has not yet been reported. In this section, we present a set of related works focused on the use of UI design patterns. These works have been grouped according to the kind of application to be developed: mobile and cross-platform applications.

2.1 UI Patterns for Mobile Applications

The UI design patterns for mobile applications have been recently studied due to the increase in the development of applications for mobile devices such as smartphones and tablets. Unlike UI patters for Web and desktop applications, the UI design patterns for mobile applications overcomes restrictions such as screen size, mobile device type and processing power [4].

Raj & Komaragiri [5] presented an analysis to identify UI design patterns in mobile devices, specifically interaction patterns. This analysis shows that a prototyping tool is useful to solve the constraints of usability and consistency, as well as reducing the time taken to develop a mobile application.

Nilsson [6] presented a structured collection of user interface design patterns for mobile applications. This paper described the use of these patterns to solve six identified problems in mobile application development: 1) screen space in general, 2) flexible user interfaces, 3) handling input, 4) not using the stylus, 5) guidelines and 6) difficult to understand. The collection of user interface design patterns has different

levels of abstraction and shows how patterns may be used to present problems and solutions in different levels of detail.

Serhani, Benharref, Dssouli & Mizouni [7] discussed the main issues involved in developing mobile applications. A framework that helps developers to build efficient, high quality and secure mobile applications was proposed. This framework was used to develop the Eivom Cinema guide. This system is a mobile application that integrates data from different cinemas information systems through Web services technology to provide users with a variety of services. Viana & Andrade [8] presented a number of challenges, among them the need for developing multi-device interfaces in different contexts. This research presented an AMB-UID (model-based UI development) environment called *XMobile* for the automatic generation of user interfaces for mobile devices. The main goal of *XMobile* was to cut down on the prototyping time of an application and to provide various adaptation levels of the user interface.

2.2 UI Patterns for Cross-platform

Several approaches are oriented to study UI patterns that can be applied in the development of desktop, Web and mobile applications.

Korozi, Leonidis, Margetis & Stephanidis [9] presented a new design framework called *MAID* that helps designers to easily create user interfaces. This design framework is complemented by a widgets library that could be used in different application panels or in entirely different applications. The *MAID* tool development process could be decomposed in the following four phases: 1) UI Definition, 2) Application Data Integration, 3) UI Adaptation and 4) Deployment.

Seffah, Forbrig & Javahery [10] highlighted the problems in developing user interfaces for multiple devices such as computers, laptops or mobile telephones. The authors presented an investigation about the Multiple User Interface (MUI) and the most important problems surrounding MUI development models. Finally, a set of HCI patterns was presented and the types of cross-platforms that are recommended for each pattern were discussed.

Märtin, Engel, Kaelber & Werner [11] explained that user experience and usability aspects have never been the main focus when developing knowledge management systems. This research described a pattern-based approach for designing highly-usable individualized multi-media interfaces for enterprise knowledge identification, structuring and communication.

Tidwell [12] presented a set of patterns according to different facets of UI design; categories include Content Organization, Navigation, Page Layout, and Actions/Commands. These patterns have been used to develop more effective UI for desktop applications, websites, web applications and mobile devices.

3 Mobile UI Design Patterns for Educational Applications

A mobile operating system, also referred as mobile OS, can operate on Smartphones, tablets or other digital mobile devices. Modern mobile OS combine the features of a

personal computer Operating System with other features [13]. Currently, the most popular mobile OS are Android, iOS, BlackBerry and Windows Phone.

- Android is a Linux-based Operating System developed by Google. Android is open source and Google releases the code under the Apache License [14].
- iOS is a mobile OS developed and distributed by Apple Inc. It is closed source and proprietary and built on open source Darwin core OS, which is derived from Mac OS X [15].
- BlackBerry OS is a proprietary mobile Operating System developed by BlackBerry Ltd for its BlackBerry line of smartphones handheld devices [16].
- Windows Phone is a series of proprietary smartphones Operating Systems developed by Microsoft. Windows Phone is based on the Windows NT kernel [17].

In recent years, mobile applications have successfully supported a lot of processes but sometimes the applications are developed for specific mobile OS, and in this case it is necessary to determine the type of interface to develop for several mobile OS. In this case, interface design patterns play an important role in providing general solutions that have been tested and have shown their effectiveness in solving recurring problems [18].

Table 1. Mobile UI design patterns for educational applications

Pattern	UI Pattern	
Content Navigation	(1) List Menu	Menu of topics
	(2) Tabs	Switch between content types
	(3) Page Carousel	Navigation between content
	(4) Expanding List	Menu of topics
	(5) Bottom Navigation	Navigation control between topics
	(6) Thumbnail and Text List	Topic with icon thumbnail
	(7) Springboard	Menu for content selection (Type of content in a topic)
	(8) Header less Table	List questionnaires
	(9) Grouped Rows	Menu of topics with sections
Search, Sort and Filter	(10) Dynamic Search	Topic search
	(11) Scoped Search	Topic search by content type
Help, Hints and Cheats	(12) Tip	Contextual help and tool tips
	(13) Walkthroughs	Help for UI Interaction
Confirm Interactions	(14) Dialog	Confirm dialog for user actions
Display Specialized Content	(15) Video	Show videos and animations
Task Progress	(16) Loading indicators	Show progress while content is loading
Group Activities	(17) Tour	Group questionnaires

The UI Patterns considered for this work is the proposal of [19] Mobile UI Patterns for Educational Applications. Table 1 present the results of the analysis of existing patterns, highlighting the following information: 1) patterns that are adapted to the educational context; 2) the pattern type, based on the classifications proposed by various authors; 3) the name of the design pattern that best fits the educational context; 4) its use in an educational context; and 5) an image of an educational application that implements this pattern. For the elaboration of this table, we have used a system called *Athena* that enables the generation of educational applications for multiple mobile devices [13].

Table 1 show some of the most representative patterns presented in [13]. These patterns have been selected based on the functionality offered in deploying educational content such as topics, images, text, animation and videos, to name but a few.

4 UI Design Patterns Support on Mobile Platforms

In order to validate the aforementioned analysis, we have selected five frameworks for RIAs multi-device. A multi-device framework is a software framework that is designed to support and facilitate the development and maintenance of mobile applications. The multi-device frameworks that were selected for these analyses are PhoneGap, Rhomobile Rhodes, MoSync, IUI and Marmalade. Evaluation was a mathematics course based on mobile UI patterns as educational software to create multi-device native applications for Android, iOS, BlackBerry and Windows Phone.

Let us suppose that we need to develop educational software for mobile devices; in this case mathematics course for grade school. The application to be developed should be visually attractive and easy and intuitive to use, in such a way that the user feels comfortable using it. It should also support the teaching-learning process through the use of educational resources. To achieve this we have two options: 1) using an HTML5-based Web application optimized for mobile devices; or, 2) developing a native application based on a mobile operating system. In order to take advantage of hardware features, it is feasible to develop native applications. The evaluation process of UI design patterns is not an easy task. The following shows the set of UI patterns available for each mobile platform.

At the end of the evaluation process, we have determined that importance of the design patterns for the educational context and the availability of each UI pattern on a framework multi-device according to the mobile platform that were be selected. Nonetheless, it is possible that, according to the type of educational application and the academic level to which this educational software is aimed, it may require some other pattern that may have been omitted from this evaluation. Table 2 shows the available UI patterns and mobile OS of each framework multi-device. The notation on the table for mobile platforms is as follows: "A" is used for Android, "BB" is used for BlackBerry and "WP" for Windows Phone. The notation on the table for the UI Patterns is 1 when UI pattern is supported on the mobile OS by using multi-device framework and 0 when the UI pattern is not supported on mobile OS.

Table 2. UI patterns support on mobile platforms using a multi-device framework

Frame work	Platform	UI Pattern																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Phone Gap 2.5	A 4.0.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
	iOS 4.0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
	BB 7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
	WP 7.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Rho-mobile Rhodes 3.3.3	A 2.2	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	0	1
	iOS 4.0	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	0	1
	BB 6	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	0	1
	WP 7.5	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	0	1
MoSync 3.1	A 2.3.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
	iOS 4.0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
	BB 6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
	WP 7.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
IUI	A 2.3.4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	iOS 4.0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	BB 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WP 7.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Marma lade	A 2.3.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	iOS 4.0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	BB 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WP 7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

5 Future Directions

We are considering identifying and adapting design patterns for the development of applications for digital TV.

We also considered more frameworks multi-device for the analysis and UI Patterns.

On the other hand, the results of the analysis of design patterns provide the opportunity to observe their use in specific contexts such as education, so it would be interesting to explore other contexts and applications of design patterns in order to clarify and obtain a more detailed classification in order to facilitate and promote their use.

6 Conclusions

This paper has presented an evaluation of UI design patterns for the development of educational software for mobile devices. This paper provides a guide for anyone involved in the development of educational applications for mobile devices that must include patterns according to their relevance and contribution in terms of usability.

We have also presented the basis for evaluating and classifying design patterns in a specific context, in order to provide guidance for software developers in choosing the appropriate design patterns for the context in which they are developing.

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