The Suitability of Native Application for University E-Learning Compared to Web-Based Application

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Abstract: *The evolution of mobile market has pushed organization and application developers to always catching up with the latest innovation of mobile technology. In terms of mobile application architecture, it is always been a dilemma whether to build an application as a native application or web-based application. This paper discusses about the suitability of mobile application architecture for educational purpose applications such as e-learning. It will focus on native application with a comparison of web-based application. This paper also discusses the importance of hybrid development approach as an alternative strategy in the development of mobile application.*

Keywords: e-learning, mobile application architecture, web-based application, native application, hybrid development approach.

1. Introduction

Nowadays, mobile application architectures have received many attentions. Mobile market has grown very fast. It can be seen by the statistics of 91% of population is using mobile phones while only 9% still uses fixed line phones. Many debates are going about web applications and native applications. Web-based application is a web based program designed to run on any mobile device through a web browser which is available in mobile devices; such as Smartphone, Laptop, and Tablet. Therefore, one development process can be accessed by all devices. On the other hand, native application is an application which resides on the devices, which involves a specific programming for only specific operating system (OS). For example, a specific application programming developed for iOS is only for Apple devices, and an android programming developed for Android devices.

As the Smartphone and tablet market growing, native application is quickly advanced and developed. Currently there are over 400,000 applications available on Apple's App Store and over 200,000 applications available on Android's Google Play. The most popular OS's for mobile devices (smartphones and tablets) are Apple's iOS and Google's Android and they are the only ones that still show growth [1]. Native application development has become a study that can no longer be ignored.

Currently, there are a lot of web applications already developed for educational purpose such as e-Learning. However, there is still lack of native application developed in such purpose. This paper will discuss the advantages and disadvantages of native application for e-Learning. It will study the possibility and suitability of native application in offering a better service for educational purpose.

2. Mobile Application Architecture

In mobile communication, there are several application architectures available to suit the needs of application users. Understanding each one of them is important to find the most suitable architecture which includes the right combination of complexities and capabilities for the planned application.

First application architecture available is a web based application. This type of architecture is the simplest form of application. It is basically a web page or a website that is made to act as an application; it can be accessed or run in the web browser of users' mobile devices. It applies the same logic of thin client application architecture which means that all of the business logic and enterprise data is stored on the server side. The users' mobile devices only need an internet browser to access the web application. Therefore, no other software required on the client side because most of mobile devices platforms such as Android, iOS, Windows, and Blackberry has their own browser already installed.

Because the web applications are installed on the server rather than natively installed on the devices, the development and implementation of this architecture is easier than other type of mobile application architectures. This is the beauty of a web application, by building only one application; it will run on all platforms. Moreover, when there is an update required, the developers only need to update the web page.

The web application are generally built with the combination of HTML5 and CSS, using Javascript and other scripting languages to do some of the more complicated tasks. There are also many other alternatives to this though and there is no standard way to build a web app [2].

Another type of application architectures available is a native application. This type of application architecture is very common and popular nowadays. It is an application developed for a single mobile platform and is installed directly onto the device. It can be downloaded from the platforms' application marketplace such as Google Play for Android or App Store for iOS. Examples of native applications are Angry Bird, WhatsApp, Kindle, and Camera360. There are many advantages that are offered by native application such as providing a better mobile devices' feature utilization; which will be discussed later on in this paper.

Native application development, however, is more complex compared to a web based application. This is due to diversity in mobile device platforms (as shown in Figure). For example, on iOS, the application must be developed using a programming language called Objctive-C in Xcode. On Android and Blackberry, the application is built using Java programming language.

Table 1: Different programming languages on diverse OS

Platforms	Programming Language
Apple iOS	Objective-C
Android	Java
Windows Phone 7 (WP7)	C#
RIM (Blackberry)	Java
Symbian	Symbian C++

Because of those complications in developing native application, new technologies are evolving to encounter it. Recently, hybrid development approaches has emerged as a new alternative application development technology. According to Adam M. Christ [3], Hybrid applications are web-based applications built into native applications. Just like a native application, it runs on the device, but it is written by using web technologies (HTML5, CSS, JavaScript). In hybrid solution, developer can use available platform such as PhoneGap or Titanium. With it, native application can be built by using a HTML, CSS, and JavaScript code and still be able to make use of device features such as the camera, accelerometer, and storage. This can be an advantage in building native application which will be discussed further in this paper.

3. E-Learning Application Scenario

In choosing which application architecture best suitable for a particular application, first there is a need to evaluate the target audience, device type, network connectivity, and security requirements. The target users of e-learning application are mostly students and lecturers. Students usually are always on the move with their own mobile devices. This might require an application which can provide all the campus services and learning support to be available anytime and anywhere. The device that they are carrying may be various. Thus, to reach a wider audience, developer needs to provide an application that can be accessed through all different mobile devices.

One of the expected usages of e-learning is allowing users to upload their documents in the application. Therefore, developers need to develop an application that is able to provide such functionality. E-Learning application should always give students up-to-date information. When it comes to giving notification to the users, this application should be able to perform it instantly.

The network connectivity is also one of the evaluations that should be considered in developing an application. There is certain time when the users might not get any internet connectivity. However, they might need immediate access the information such as lecture notes or uploaded articles. E-learning should be able to cater this need. Security wise, E-learning may not involve a very sensitive data. However, it does not mean that the data should not be secured. There is still authentication method to be installed. It can also best applicable in the scenario where an application should differentiate between different type of users; such as lecturers or students.

4. Web-Based Application

Mobile web growth is eight times more than desktop web growth. Smartphone sales are passing PC sales since 2011. Therefore, organizations have recognized the importance of mobile technologies in order to maintain their position to lead in the market. Web-based application which can be accessed through the browser of a device is assured to be the one solution to fits all platforms.

4.1 Effective Development and Release Process

In providing application that can be accessed through different platform, building a fully responsive web based application is a way to go. Developing cross-platform web applications with a single codebase (HTML) is a strategy that allows organizations to stay ahead in the mobile advancement. Developing a web application only requires one cycle of development for all browsers. In native application, it requires one development cycle for each of different OS or platforms. Therefore, cost savings and benefits in the development process are significant in web application.

Differences still persist in the implementation and technical specifications between varieties of browser platform such as Safari for iOS, Android, and WP7 (Internet Explorer). However, there is a web standard which includes a formal set of recommendation that those browsers are expected to support. This standard provides a consistent user experience regardless of operating system (OS) or devices. It gives a functional foundation to the users and developers of websites and web application. In that sense, mobile browsers are the great equalizer in the realm of mobile technology [4].

Because web application resides on a server, it can be updated easily. Developers do not need to push users to download and install every updates. Application store; the center for downloading native applications usually requires approval for any updates made by developers. By going with web application, developers do not need to request for approval every time there is an update in an application.

Viewing web application only requires a web browser; therefore, it is essentially a multiplatform solution. It provides platform independence which gives a better chance of reaching users in the widest possible way.

4.2 Limitation in Browser Functionality

Although web based application have strength in development and release process such as mentioned above, but they have several functional limitations that organizations such as university must consider to move towards native application development.

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Currently, web applications are still hampered by the functional limitations of mobile browsers. The advancement of mobile device produces additional capabilities such as Bluetooth, cameras, GPS, and telephony that can be used by users. Native applications are able to exploit these functions, whereas browsers usually cannot provide those functions. Native application allows appliance of photography, location services, and wireless pairing games. Each of the browsers has their own limitation as well. For example, Safari does not allow users to upload files in the File Upload fields. It is a restriction from the browser and the operating system. Therefore, a web application that require uploads must find other suitable solutions.

5. Native Application

Because of the trend in native application, organizations and companies has faced many demands to develop one. There are many reasons users prefer native application rather than web-based application. According to Research commissioned by Compuware APM done in March 2013, 85% of mobile device users preferred native application because of their speed, high quality interfaces, and platform features that cannot be provided by web based application. There are a lot of consideration must be done before deciding to be involved in the mobile market.

5.1 Benefit for Educational Purpose

There are a lot of advantages that native application can offer more than web-based application. The most essential benefit that native application can provide for e-Learning is the ability to send push notification to its users. E-Learning users; such as students and lecturers, they need the most updated information. Thus, notifications and updates are very important to be included in such application. Even though web-based application can be accessible through all web browsers, it can only give updates and notifications to their users if the website is opened. Native application can send push notifications to the users even without opening the application which is impossible for a web-based application [5]. This is particularly very convenient for any emergency and important notifications such as cancelation of classes or reminder for assignment submission due date.
The ability of real-time and push notification in native application can also extend the feature of e-Learning in social networking. It allows the possibility of implementing more up-to-date and alive chatting and forum than web-based application.

Mobile device nowadays provide many features and capabilities that can be utilized by native applications. Bluetooth, cameras, GPS and telephony can support e-Learning application for photography and location services. This is useful to be implemented in advanced e-Learning features. For example in maps, it can use GPS to locate the user and showing their destination. It can also use the camera to capture pictures then possibly to be immediately uploaded and shared in the application. The use of calendar can also be utilized for users' scheduling system. This features incorporation is limited in web-based application.

Another benefit that can be provided by native application is the ability to provide data anytime even when the user is not online. Native application usually contains a persistent data storage mechanism as well as business logic [6]. It allows data to be stored in mobile devices. Thus, it is able to function without internet connectivity. This characteristic is one of the reasons why native application is always become the chosen application architecture for sales force automation (SFA), data collection application, and healthcare application. In particular, this characteristic allows users to get immediate access to information at their fingertips, which is suitable for educational application such e-Learning.
Native application also offers faster performance. This is because less data and graphics are being transferred over the internet. It also can leads to ability to provide better interface and graphics to the users. Therefore, users can have better user experience and become more familiar with the applications.

5.2 Development Complexity

In developing native application, there are a lot of challenges that must be understood. This can help an organization to choose and capitalize on the methods, the processes and technologies of native application. In his paper, Daniel Y. Na, mentioned several challenges in this area [4].

Firstly, developing applications for mobile devices involves cross-platform complications. High competition in mobile device industry has leads to non-standardized and different platforms available in the market. The three major mobile OSs such as iOS, Google Android, and Windows Phone 7 (WP7), requires different programming languages. It is certain that organizations and companies who develop mobile application are aiming to reach all of its users or customers. Different users might have and use their own preferable brand of mobile device. Therefore, organizations should consider providing an application which can be accessible by those three major Oss. However, it requires tools, resources, and expertise to do so. This challenge does not only happen across various OSs, but also happen within a certain OS. Sometimes, even an OS such as Android has many versions which require upgrades. This affects application to change its code. Therefore, developers are forced to simultaneously upgrade its application to match the latest technology and OSs version. It is also possible that new applications cannot run on the older version; for example, new Telegram application. Therefore, it is a challenge to build an application that is compatible to all OSs and its many versions.

It is also a challenge for the developers to accommodate different and unknown specifications of different hardware such as screen size, input mode, storage capacity, RAM, and processing power of various devices.

Different OS have different policy. If the OS owner unexpectedly changes to their policy, it can become a difficulty in developing a native application. This case happened in 2007 when Apple suddenly change its subscription cost model [7]. Apple forced all application

payments to be processed through Apple instead managing the payments on their own sites.

6. Hybrid Solution to Simplify Development of Native Application

It can be seen from Table 2 that the significant drawbacks of Native application are mostly based upon the complexity of development process. Other than that, native application can give more benefits compared to web based application; such as better integrated device features, ability to perform offline, and allow push notification. If only developing native application can be simpler, the cost of development and maintenance can be reduced. Luckily, the technology advances has produce recent innovation that allow developing application across platform using a single codebase.

This is where hybrid development approach can be an alternative strategy in developing a native application. As it is shown in Figure 1, in native application development, there will be a development involved for each of the OS. As of web-base development, only one development involved, it will be released in the internet and all browser in every OS can access through it. However, web-based applications are restricted to the browser and have limited access to device features. Hybrid development approach adopts the best of each approach (native and web-based). In the development process, it adopts the simplicity of web-based development approach where it only requires one development cycle. Moreover, it adopts the better performance and capabilities then web-based application, because it resulted in native application.
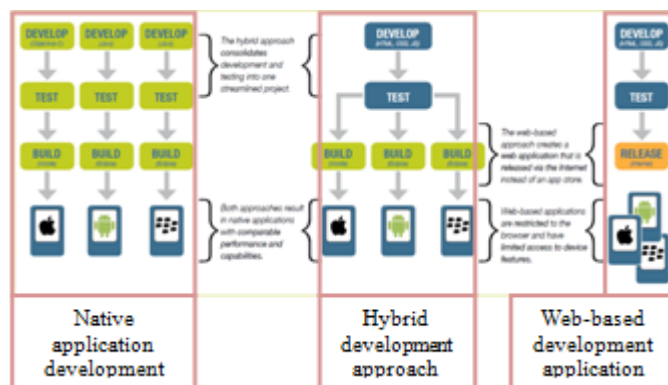

Figure 1: Hybrid development approach is closing the gap between native and web-based application development

Hybrid development requires a platform to compile the HTML5, CSS, and JavaScript into a native application with comparable performance and capabilities. There are many hybrid platform currently exist such as PhoneGap, Titanium, appMobi[!], and rhomobile. Any of them allow developers to create a native application using web technologies. However, there are differences between those platforms, and there is no single platform is best for all projects. Therefore, further analysis of each of the platforms' features, requirements, and availability is important to help the developers to select which one is the best for a certain projects.

7. Students' Preference on Native Application

According to a research done by Kyle Bowen in Purdue University [8], students see themselves as skilled smartphone or tablet users. The survey reported that 76% of students prefer native applications for most of their mobile activities. It includes educational activities where 49% of students prefer to use native application and only 34% students prefer using web browser (Figure 2). It is then explored more in specific educational tasks that student perform with their mobile device. The result showed that students prefer to use native application rather than web browser (Figure 3)
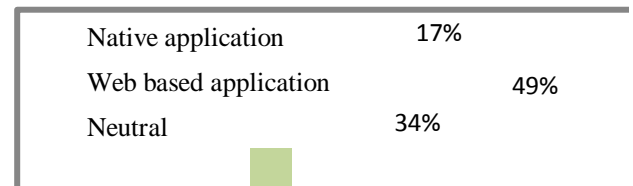

Figure 2: Students' preference for educational activity in mobile device [8]

Figure 3: Students' preference for mobile access by course-related task [8]

Seeing that many students prefer native application over web based, several universities have taken their application ahead. There are several native application exist for e-learning in Malaysia.

8. Conclusion

After analyzing several criteria, it is concluded that native application is the most suitable architecture to be implemented for e-learning application. In comparison to

web-based application, native application able to outperform in terms of performance, user experience, offline availability, device feature incorporation, and security (table 2). Especially for educational purpose, those characteristics can complement E-learning application in a better way. It is even way more popular among users. Therefore, despite being more expensive and time consuming, the benefits of native application will outweigh the cons [9]. In terms of development complexity, there is alternative strategy such as hybrid development approach that can simplify native application development process. Moreover, it can help organizations to reduce development and maintenance cost. It is recommended for organizations to develop a native application e-learning in order to provide better user experience to their customers, students, and lecturers.

Table 2: Comparison between web-based application and native application

	Pros ☐ Cons ☐	
	Web-based application	**Native application**
Application development	Single application development.	Multiple application development for multiple platforms.
Cost	Lower costs due to single codebase and common skill set.	Higher costs due to multiple platform application development and maintenance.
Portability	Easy creation for cross platform version.	Separate version required for each OS.
Deployment and Update process	Simpler process. Only need to update application on the server side. No need for approval to update application from App store.	Complicated process. Need the user to download and update the application on their devices. Need update approval from App store.
Availability	Not available without internet connectivity. Not available if the server down.	Can be accessed even without internet connectivity.
Devices' Feature access	Limited access to mobile device features.	Incorporates all mobile devices' features.
Push notification	Not possible.	Can be sent directly to user.
Performance	Network latency.	Faster performance.
User Experience (interactivity)	Limited user experience.	Better user experience.
Security	Wireless gateway may lead to security concerns.	More robust security.
Offline features	Limited offline support	Best support for offline features. Provide native data storage
Popularity	Less popular among mobile device users.	More popular among users.

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