An M-Learning Open-Source Tool Comparation for Easy Creation of Educational Apps

Antonio Ortega-García, Antonio Ruiz-Martínez(✉), and Rafael Valencia-García

Faculty of Computer Science, University of Murcia, Murcia, Spain
arm@um.es

Abstract. Since the use of smartphones among students is usual, the introduction of mobile technologies in teaching and learning processes (m-learning) is becoming more and more frequent. Indeed, there are an important number of m-learning experiences using general purpose apps such as Dropbox, Facebook, apps provided by the mobile OS, etc. However, there are situations where it could be convenient to develop a customized app. The aim of this paper is making an analysis of the different open-source tools for creating m-learning apps that do not require prior knowledge of programming and choose the most mature for this purpose. Thus, the creation of these apps could be made by any teacher. We evaluate the usefulness of this tool, its accessibility for teachers without previous knowledge in programming apps, and the utility for students. Our choice was App Inventor.

Keywords: Educative app · Mobile learning · Ubiquitous learning · Virtual classroom · Creation tool

1 Introduction

Mobile learning (m-learning) approaches the use of Information and Communications Technologies (ICT) for delivering the benefits of mobile technologies in the field of teaching in a familiar way for students. Namely, its main benefit is that it facilitates the learning process anywhere, anytime. Furthermore, as stated by UNESCO [1], m-learning has a set of unique features such as: expanding the reach and equity in education, facilitating personalized learning, providing immediate feedback and assessment, etc.

Being a powerful technology of widespread use, its integration in the field of teaching is only a matter of time. Mobile technologies are not the future, they are already fully implemented in many aspects of society. According to the report published by UNESCO about the future of m-learning [1] the next decade and beyond could radically transform the incorporation of mobile technologies to formal and informal education in order to meet the needs of students and teachers from all over the world. Indeed, more and more companies engaged in development of educational content for mobile devices and worldwide market

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for m-learning products and services is expected to grow in the next years[1]. Furthermore, as the use of mobile devices is extended among students, some organizations are adopting BYOD (Bring Your Own Device) policies allowing students to connect to institution's network to learn by means of technology in the classroom [3].

Developing useful m-learning resources for students is difficult and the success of this kind of learning largely depends on the ability of teachers to take advantage of mobile devices as stated by Mouza [3], since not all teachers have the necessary skills for the appropriate development of educational mobile applications. Therefore, it is necessary to find a way to unify and simplify the development of all types of m-learning resources and take advantage of the use of different m-learning technologies available, in order to facilitate this work to teachers.

Currently, most of m-learning experiences are based on the use of general purpose apps such as Dropbox, Facebook [4] or apps provided by the mobile OS [3,5–7]. However, these apps limit the kind of experiences teachers can perform. Thus, it would be desirable that a teacher could develop its own m-learning app customizing contents, resources, including tests, using mobile features such as GPS, etc.

Our research work aims at studying different tools for creating educational resources on mobile devices to save these obstacles, assess whether it is powerful enough to generate resources of interest for students, and simple enough to offer teachers the generation of these resources, whether or not teachers have advanced computer programming skills. We aim to select the most suitable tool for the development of m-learning apps for non-programmers or beginners to easily generate apps that can be useful in the learning/teaching process. Hence, in this work we have analysed the available tools and, then, we selected App Inventor.

The paper is organized as follows: first, the general and specific objectives of the study are presented in Sect. 2. In Sect. 3 an overview of the theoretical framework necessary to identify the most important features of m-learning education is explained. In this section the criteria for identifying the most appropriate tool are presented. In Sect. 4, we present our main findings and a discussion of the results obtained. Finally, conclusions and issues to address in future work are obtained in Sect. 5.

2 Objectives

The aim of this paper is to make an analysis of the different open-source tools for creating apps that do not require prior knowledge of computer programming languages so as to choose the most mature and easiest tool for this purpose. Thus, the development of these apps could be made by any teacher and not only by a computer programmer, that is, for beginners or non-programmers.

[1] http://elearningindustry.com/elearning-statistics-and-facts-for-2015.

As these tools are open source, they could be used by any teacher although its teaching center (school, high school, university, etc.) has limitations in the budget (e.g. urban teachers in low-income underserved schools), and some professional development program could be developed easily in order to help teachers to incorporate mobile devices in teaching and learning, which is an issue that has not been deeply addressed, as Mouza sets forth [3]. Some examples of development programs can be found in the studies provided by Ekanayake and Wishart [10] and Saudelli and Ciampa [9].

2.1 Related Work

Nowadays, most m-learning studies [11] of m-learning are focused on effectiveness and m-learning system design, being mobile devices and PDA the most commonly used devices. Most of the experiences are based on the use of social networks or apps that are included in the mobile OS [3–7]. However, the purpose of our study was to find a tool that allows non-programmer teachers to develop m-learning app adapted to their teaching needs.

As a tool we have chosen App Inventor. There are a number of m-learning experiences developed with this tool (a list of them can be found on its Web page[2]). Among these experiences we highlight the experiences performed by Robertson [12] and Soares [13].

There are other works similar to the already mentioned that are also based on App Inventor, but, as the ones already mentioned, they are focused on the same point of view: how to use App Inventor so that their students create apps to learn to program or some issues related to programming. Namely, Turbak et al. [14] used it to teach the event-based model and Morelli et al. [15], Wagner et al. [16], Karakus et al. [17] and Gestwicki and Ahmad [18] use it to teach Computer Science principles and introduce them into the programming of computer applications.

Scherer et al. [19] performed an interesting study about the current teacher's acceptance and use of information and communication technology (ICT) signifying different facets of ICT-related teaching goals in classrooms. Teacher's perceived usefulness of ICT for teaching and learning is proven to be a very important factor that will be taken into account in our study, since it is positively related to self-efficacy and ICT use.

3 Theoretical Framework

In this section we present the theoretical framework needed for the understanding of our study. Thus, we analyse what m-learning is and its main features. Finally, we present a summary of the main existing tools for creating m-apps without previous knowledge in computer programming languages.

[2] http://appinventor.mit.edu/explore/research.html.

3.1 M-Learning

M-learning could be defined as teaching and learning taking advantage of the use of mobile technologies in such a way that they will allow the learner to perform the learning process without being in a predetermined or fixed location [11,20,21].

Nowadays, this kind of learning is possible thanks to the technological advances made in communications, wireless technologies and mobile devices. In recent years, m-learning has been significantly expanded according to Jim, Chen, Lin and Huang [11] and, as mentioned in the UNESCO report [1], in a close future, it will be more integrated and widespread in formal and informal education.

The use of these technologies has broadly shown its positive outcomes in different education context such as formal education, non-formal education and informal education [11]. However, as Chu [22] explains, we must consider the negative aspects of these technologies. A non-appropriate application of these may subject students to a high cognitive load, hurting their learning process, distracting and overloading them.

In order to understand why m-learning will be so important in the education system, we studied and classified below the various educational features that these tools are able to offer. This classification will be useful in establishing the criteria for comparing the existing tools and selecting the most appropriate.

3.2 M-Learning Educational Features

The obvious educational potential that mobile technologies have (geolocation, mobility, connectivity, apps, conferences, access to information, sharing, etc.) arises various educational features applicable in various areas of teaching.

The most immediate and obvious quality of m-learning is to learn *anywhere and anytime*. This feature enables continuous learning throughout life, without time frames, mixing education with everyday activities. A mobile device is a teacher/student who follows you at all times.

One advantage is the freedom to capture ideas when inspiration strikes, and getting knowledge when doubts appear. If in a visit to a museum curiosity and the urge to know more about a subject or author comes to us, we only have to surf on the Internet at the same time.

The functionalities of mobile devices have a large number of direct applications in education: synchronization, creation of joint tasks, information sharing, content creation by the student (graphics, images, videos, presentations, podcasts, etc.), generation of learning communities, live broadcast recordings and interviews, measurement of gravitational forces and magnetic signals, etc.

These tools have the ability to be motivating and attractive to the student. The proper use of these devices is motivating itself. Furthermore, being a lower-cost tool than others allows great access to all kinds of students and teachers. All this favours a more active role in their education for the student.

Mobile devices allow a much more personalized education. By the connection you get with mobile applications and the use of the Internet, a person can choose between their centers of interest and learn continuously and immediately, either the date of a historical event or how to repair the appliance that has failed. The flexibility these devices provide allows an education suited to the needs of each individual.

The m-learning feature of *learn anywhere and anytime* also allows the expansion of experiential learning based on location, which refers to a specific location, and the knowledge gained by the experience made at this location, through tours, museum visits, cultural sites, etc. For example, Walker [23] suggests methods for sharing information among museum visitors through m-learning activities.

The ability to provide a connection between students and teachers anywhere and anytime allows continuous monitoring of the learning process. This means that the teacher receives much more information about the difficulties of her students when assimilating specific knowledge, and the student is more aware of this learning process, being able to construct their own knowledge.

Another important feature of m-learning is the social interaction. The ease to connect educational projects among classrooms around the world, and monitoring of these projects anywhere and anytime, allows students to participate in educational activities correlating with all kinds of students, from classmates, to even people of other cultures, without barriers of space or time.

3.3 Tools for Generating Apps for Non-programmers

Currently, there are available many dedicated tools for creating mobile applications. In this section we provide an overview of the main available tools. Then, from this analysis, we present the tool we have selected as the more powerful and easy to use. Below we establish criteria on which to compare and choose the most suitable one.

The main available tools are: Claro, Appulse, Impatica, Learncast, Adrenna, H5P, SmartBuilder, Blackboard and App Inventor. Next, we provide a brief description on each one.

Claro[3] is a tool of electronic learning (e-learning) Web-based collaborative environment. This tool lets you create and share courses, adapting the content for mobile devices, hosting them in the cloud. It provides an environment for online/offline full development without the use of accessories, to create responsive HTML5 content. It uses design templates for the preparation of the contents. Its target audience is primarily the private sector and collaborative environments, but it can also adapt their applications to m-learning.

Appulse[4] is a multi-platform application that offers an easy-to-use solution. It focuses on entrepreneurial business environment, but it also provides e-learning functions. It has an attractive visual presentation, focusing on the use of images and videos with little text. It provides document sharing and synchronization

[3] http://www.dominknow.com/.
[4] http://www.jdb-smartlearning.com/en/content/downloads.html.

between all devices. The mobile application is synchronized with Moodle natively and offers shared storage in the cloud, these are attractive qualities for an application of m-learning.

Impatica[5] is a conversion and content creation software which enables the transformation of various types of documents, such as PowerPoint or Word, in presentations to mobile applications. It also allows the integration of content embedded on Web pages. Its aim is to create presentations quickly and easily, and make them immediately available to users. However, its range of functions and applications for teaching is rather limited, focusing almost exclusively on the creation of multimedia content.

Learncast[6] is a tool dedicated to the creation that allows the integration of surveys and provides feedback information easily. It provides real-time measurement of results and allows the discussion of these through forums. It introduces a concept of rewards by medals, which rewards the user for completing certain tasks, and uses a system of alerts and notifications for urgent content.

Adrenna[7] is an e-learning platform that records the work done by the teacher to compare educational standards and learning objectives. Its aim is to provide learning environments tailored to the user. It allows the migration of content from other platforms. It is developed by Drupal and its code is accessible, so that it can be easily updated with applications made by the community.

H5P[8] is an application for creating HTML5 content in the browser. The development platform allows you to add and update content at any time, and share it through HTML5-compatible devices. However, rather than focusing on the development of a learning environment, it focuses on the development of multimedia content, offering a few features of coordinated learning and progress tracking. It has good documentation with presentations and examples of use.

SmartBuilder[9] is very similar to H5P tool, virtually identical. It also focuses on the elaboration of multimedia content for environments that support HTML5, using a system based on the click and drag objects environment. Like H5P, it allows a few features of learning. It focuses on the use by groups of collaborative work. It also allows the use and sharing of templates for processing applications.

Blackboard[10] is a virtual learning platform compatible with mobile devices, which provides a simple user interface, online assessment and surveys, designed to encourage active collaboration throughout the course and creating project groups. It is based on the use of 5 different platforms interrelated, learning, collaboration, connection, mobility and analysis. It offers a different product depending on whether the studies are primary, secondary, complementary or superior.

[5] http://www.impatica.com/.
[6] http://www.learncast.com/.
[7] http://www.adrenna.com/.
[8] https://h5p.org/.
[9] http://www.smartbuilder.com/.
[10] http://es.blackboard.com/.

App Inventor[11] is an online free development environment for mobile applications, developed by the Research Institute of Massachusetts, primarily aimed at the use for education and research. It offers many educational applications and is synchronized with the mobile device so that all changes are instantly reflected. It has a very broad user community that actively generates features and documentation. To use it, it only requires a Gmail account. It does not offer cloud services. However, projects created with this tool are stored on the server.

As part of our research work we have made a detailed comparison on these tools that we present in Sect. 3.4.

3.4 Comparing Tools and Selection

In this section, on the one hand, we establish the set of criteria that we used to compare the different tools (see Sect. 3.3) that can be used to develop apps with previous knowledge in computer programming languages. On the other hand, based on these criteria, we compare the different tools and select the most interesting one.

To meet the desired objectives, the finally selected tool must meet the previously studied educational features, which must meet the following requirements:

- No programming skills required: it must enable teachers that are beginners and non-programmers to create apps.
- User-friendly: it should not take long time to learn how to use the tool, and should enable rapid content creation.
- Documentation and support: It is important for the tool to have a good documentation. Even more, it is positively assessed that the tool is widely used, and, even more so that there is an active community of users who currently develop documentation and content, with some help from forums, examples and similar applications that can support the development of applications.
- Multi-language support so that it can be adapted to the local language.
- Reuse: the tool must allow prolonging the validity of the developed applications.
- Cost of the tool: it is assessed whether the tool is free or paid, and if the contents developed are freely distributed to students or if they need some type of payment or account to access them. It is better considered that the tool is free and/or open-source since, thus, the educational center or the teacher does not have to make investment. Hence, it can be used by any educational center independently of their economical resources. Furthermore, the use of open source tools maximizes the range of students with access to the tool, which could lead to perform a meaningful experience.
- Analytical results: the provision of analytical results is interesting, for both teacher in controlling the process of teaching and students in the self-evaluation process.
- Feedback on the user experience: it offers analysis about the use of the application by the students, allowing comments about the issues occurred.

[11] http://appinventor.mit.edu/.

Table 1. Comparison of tools for the generation of apps

	Claro	Appulse	Impatica	Learncast	Adrenna	H5P	Smartbuilder	Blackboard	App Inventor
No programming skills required	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes
User-friendly	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Documentation and support	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MultiLanguage	Yes	Yes	No	No	No	No	No	Yes	No
Reusable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cost	97/month	Payment*	Payment*	Payment*	Payment*	0	0	2.00	0
Analytical results	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Feedback	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes
Content sharing	Yes	Yes	Powerpoints	Yes	Yes	Yes	Yes	Dropbox	Yes
Information processing	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cloud server	Yes	Yes	Yes	Yes	Yes	Yes	Unknown	Yes	Yes
Integration services	No	No	No	No	Yes	Yes	No	Unknown	Yes
Multiplatform support	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Android

- Content sharing: all the information related to the courses can be presented and immediately updated online at any time.
- Information processing: it should allow the presentation of information to students and teachers in order to gather data and process the information in many formats, such as tables and forms.
- Cloud service: it should allow the use of cloud servers so courses, materials and information can be always updated and students can access information anytime and anywhere.
- Services integration: it should support the use of online services such as social networking, mail, cloud storage, etc.
- Multiplatform support: it should allow the development of applications for various mobile platforms (Android, iOS and Windows Phone). Thus, we could reach all students independently of their device.

Next, we make a detailed analysis of the tools presented in Sect. 3. The assessment of the various aspects of each tool, based on the criteria presented, is reflected in Table 1.

In Table 1 we can see that most of these tools provide powerful solutions without programming knowledge. Indeed, except H5P, Smartbuilder and Adrenna, the rest of them allow us to develop m-learning apps without previous knowledge. Smartbuilder is a powerful tool, but more complex than what we need, which restricts the use for many teachers. H5P and Adrenna require a previous installed setup in a platform like Joomla, Drupal or Wordpress for integration of the tool. These are not the conditions we are looking for.

All the tools analysed are easy to use and have good documentation and support, AppInventor being the one that provides more examples, tutorials and applications, with the wider community of users and specific forums for many subjects, as teaching. The support of the multilanguage feature is not available in all the tools. Only Claro, Appulse and Blackboard have been taken into account. The fact that a tool has not this property is not significant because we can create different versions of the same application in the different languages, which

involves more development time. Regarding reusability, we can mention that these tools facilitate that the development made can be re-used to create other projects.

As for the cost of the tool, these solutions are, in most cases, very expensive. During the realization of this study, it was observed that most existing development tools offer proprietary software solutions that requires payment for its use (those marked with Payment*). Many of these tools even require registration process and a preliminary study for the realization of a budget. The cost of these tools varies depending on various factors like the educational services contracted, the number of users, modules, etc. As we defined in the previous list of requirements, we discard any tool that supposes a payment since we want to maximize the range of teachers and students with access to the use of the tool. Then, according to this criteria the best options are: H5P, Smartbuilder and App Inventor.

Except Impatica, all of them allow analytical results in one way or another. Most of them just provide the methods to manually send the student's results to teachers and to create tables with the desired information for the student's feedback, which is sufficient. However, Learncast provides automatic test and tracking student's progress with instant result and feedback. Since the specific nature of Impatica is being a tool dedicated to conversion of content and sharing, it does not allow feedback neither for students nor for teachers. H5P is dedicated to course presentations and interactive multimedia content sharing, so it does not provide feedback neither.

All the tools allow to share content and information, which is essential for a teaching tool. However, Impatica is restricted to the use of powerpoints, which is very limited for our objectives. Blackboard seems not to provide file management in their learning core pack, however, we can still share files with our students through free platforms like dropbox, even though this is privative software and requires registration of every user.

Regarding information processing, all of them allow to collect and present information and results. AppInventor does not provide a direct way of processing the information since it only allows to create lists, but nevertheless you can still manually create tables, graphs and forms to collect results with the tools provided. As for cloud service usage, App Inventor allows cloud services to save courses and update them, however, this is very limited, and for further cloud usage such as files sharing online the user should find a way to integrate cloud services on their own. Cloud functionalities are rarely provided by free tools, this being an expensive service. Most of the payment tools provide some kind of cloud service.

The integration with other services, such as online videos or mailing, is not explicitly indicated by the features of most tools. However, even if they do not provide specific tools to integrate this services, this is a minor issue, as we can always include links to dropbox, youtube, gmail, etc. However, it is appreciated that Adrenna and App Inventor provide automatic ways of services integration. Adrenna provides a feeds service integration, while App Inventor includes all

kinds of automatic services integration tools such as twitter, phone calls, texting, mailing and translation. All the tools provide solutions compatible with at least Android and Apple devices, except for AppInventor, which is only compatible with Android technology.

From the tools analysed the most interesting are Learncast, Appulse, Smartbuilder, Adrenna, and App Inventor. Smartbuilder seems the most powerful and customizable solution, but it is excessively complex for the purposes of this study, since we prefer a simple and easy solution that allows access to more teachers instead of a more complex and powerful solution. Adrenna is a very complete solution, however is more an e-learning than a m-learning tool, and it does not provide as many specific services that take advantage of mobile devices as other tools do. Learncast and Appulse would be the most interesting options if we were aiming for a payment tool, since they provide all kinds of m-learning services, they are simple, easy and attractive, and compatible with most mobile devices. Among the free tools, H5P is discarded for requiring a previous setup and configuration. Only App Inventor provides an interesting solution for this study, and is the most powerful of the free tools, being very competent even comparing it with the payment ones. It is intuitive and potent, providing an easy and fast way to create mobile apps for free distribution, and it counts with the wider community of active users, providing the creators access to active forums dedicated to teachers and developers, help, examples and tutorials. This tool is very accessible and user friendly for all kinds of teachers, and this is the most important aspect to cover in this study.

Therefore, once we have analysed all the options available, from our point of view, the tool App Inventor is the most interesting one for the development of m-learning apps.

4 Result and Discussion

App Inventor is a cloud service that does not require the installation of any software. The mobile application is developed through a user interface via web. In addition, a feature that is very interesting is that the tool is synchronized with the user's mobile device. Thus, all changes made to the application can be tested at the same time it is developed. This tool use is widespread and gradually increasing, with an asset base of over 250,000 users, and more than 3 million registered.

Another great attraction that has made us opt for this solution is the large active community of existing developers. On its website we can find an exclusive forum for teachers. The number of examples, tutorials and support is broad enough so any teacher can rapidly get started in content development.

This tool requires the use of a Gmail account, but it is open code and the content created is owned by its author, in our case, the teacher. This means that the content created can be freely distributed without any restriction or hindrance among students, who do not even have to create an account to access them.

Applications and content created are completely reusable from a course to another. Applications are generated in .apk format, so they will work on Android

phones as usual. The contents and projects are saved and associated with our Gmail account, so at any time you can access, update a new course, or even download and save them on your computer. However, the generated applications only work on Android platform, which restricts the number of students who can access the content generated for not being compatible with iOS or Windows Phone.

The application does not require any programming knowledge. Everything is done visually by means of blocks. After finishing the application, the tool generates an APK that you can download on your computer. Then, you only have to make it available for students to download it into their mobile devices.

5 Conclusions and Future Work

Nowadays, both teachers and students has a mobile device, which has favoured the widespread of using them in learning/teaching processes. So far, most of the experiences are based on the use of apps that are specifically designed for m-learning processes such as iBooks, Facebook, etc. However, a teacher, with no knowledge in computer programming, might want to develop apps that are adapted to her teaching needs. For this purpose, we studied the tools that are available for non-programmers and, after analyzing them, we conclude that the most suitable was App Inventor.

The fact that the tool is easy to use for non-programmers and it provides functionality to manage the different elements of a smartphone, we have identified some shortcomings: lack of sync with cloud services, not processing the information easily within the application with generated graphs and its dependence on Android technology. In the future these deficiencies could be addressed to improve the features that m-learning apps could offer. Even so, this tool has the important limitation that it is only valid for Android smartphones and there are other mobile OS that have an important penetration as iOS or Windows Phone. Currently, there are some application that support the generation of the app for multiple mobile platform. However, in most cases they are expensive or require knowledge in programming. Therefore, it is needed a simple and powerful tool to extend the development of these m-learning applications to all available devices which makes it easy for teachers to create these apps that allow them to customize the learning process of their students. From our point of view, this is the key to boost the m-learning.

As future work, we aim to develop a teaching experience to evaluate the acceptance of this tool (App Inventor) among teachers and students, and the difficulties they could find in the development and use of m-learning apps, as well as its usefulnes in education.

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