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Student projects empowering mobile learning in higher education

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Abstract

Educational institutions are facing the challenge of providing students with tools for mobile learning (m-learning). However, the evolution of technology makes the development and continuous improvement of these tools rather expensive. For example, it is difficult to assess the different technology options available and to choose which ones are best suited to a particular context. In this article, the proposed solution is to engage students on technology degree courses in the development of m-learning tools. The Open University of Catalonia (UOC) is analyzed as a case study, and several examples of tools developed by students as part of their final year projects are presented. These projects explore different technologies and provide useful information to guide institutional investment in the development of m-learning tools. Akin to the collaborative development model in the field of open source software, this paradigm therefore can ensure the sustainability of m-learning in educational institutions.

Keywords

final year project, mobile device applications, m-learning, e-learning tools, innovation

Proyectos de los estudiantes para potenciar el aprendizaje móvil en la educación superior

Resumen

Las instituciones educativas se enfrentan al reto de ofrecer a los estudiantes herramientas para aprendizaje móvil (m-learning). Sin embargo, la evolución de las tecnologías hace que el desarrollo y la mejora continua de estas herramientas sea algo muy costoso. Por ejemplo, resulta complicado evaluar las diferentes alternativas tecnológicas disponibles y seleccionar la más apropiada según el contexto. En este artículo, se propone como solución implicar a los estudiantes de titulaciones tecnológicas en el desarrollo de herramientas de m-learning. Se analiza como caso de estudio la Universitat Oberta de Catalunya y se presentan ejemplos de herramientas desarrolladas por estudiantes como parte de su trabajo final de carrera. Estos trabajos permiten explorar diferentes tecnologías y proporcionan información útil para guiar la inversión institucional en el desarrollo de herramientas de m-learning. Así pues, este paradigma, cercano al modelo del desarrollo colaborativo en el software libre, permite asegurar la sostenibilidad del m-learning en instituciones educativas.

Palabras clave

trabajo final de carrera, aplicaciones para dispositivos móviles, m-learning, herramientas de e-learning, innovación

1. Introduction

According to some authors (Traxler, 2006; Frohberg, 2006; Sharples, 2010), we are living in a so-called 'mobile era', and there is talk of a new revolution at hand; a revolution where mobile devices play a key role. The rapid evolution of wireless technologies and the unremitting development of applications (apps) for mobile devices in recent years are good examples of that. In particular, new types of devices have burst onto the educational scene regardless of the day-to-day activities undertaken by educators and educational institutions.

Wireless technology and mobile devices are getting faster and more powerful all the time. In fact, there is now a tendency to replace desktop and laptop computers with other types of devices that require a different kind of interaction. In addition, there is currently a proliferation of tools and programming languages to develop mobile device apps and, simultaneously, a relentless growth in the specific marketplaces for publishing and sharing apps of this type. In the sphere of education, the demand for new apps to adapt learning environments to new mobile devices is driving the need for more and more work to be done on them. Some authors have identified major opportunities in the field of higher education, one of them is Alan Livingston. He has noted that the use of mobile devices by higher education students is practically universal, which, in his opinion, represents an excellent opportunity (Livingston, 2009).

The new context enables students – as users of mobile devices with access to a communications network – to study anywhere and anytime. Faced with this new scenario, educational institutions have no option but to adapt; they have to modify their platforms to enable various means of access to resources from different types of device. The objective must be not to lose the competitive advantage (Cobcroft et al., 2006).

Apps to facilitate learning via mobile devices are usually developed by the development departments of educational institutions. However, in the current times of economic difficulty, some ostensibly interesting projects may not be viable because the investment they require is too great. However, if the aim is to narrow the digital divide, then it is essential to work on innovating learning environments and platforms. It is crucial to look for alternative options in order to adapt to this new reality.

In the particular case of higher education institutions offering information technology (IT) degrees, it should be noted that final year students have the necessary skills and knowledge to become potential developers. An advantage is that they are already familiar with the environment and its requirements, and this enables them to solve certain problems that they have clearly identified. So why not capitalize on this situation? If creating such tools for their own benefit and for that of their fellow students – and, by extension, for that of the educational community – motivates them, then why not help them do so?

Many earlier proposals in the spheres of e-learning and m-learning have promoted the figure of the student as a creator of teaching content (Kukulska-Hulme, 2007; Hernández Requena, 2008), in keeping with the philosophy whereby content emerges from Web 2.0 user contributions (Alexander, 2006; Ferguson, 2011). However, the idea put forward in this article goes further, as it proposes that students should become the authors of (or at least contributors to) their own m-learning tools.

Considering this option as a sustainable methodology from a financial perspective, the university or educational institution in question should: 1) provide a minimal set of tools to gain open access to certain institutional data in a controlled, secure way, and 2) set out procedures that firstly enable new apps to be developed for the institution and secondly facilitate their integration into the learning platform, in a similar way to how apps are created in open source software communities.

At the Open University of Catalonia (UOC), this opportunity has been identified: in the Computing, Multimedia and Telecommunication Studies, besides their role as m-learning consumers, students are being encouraged to become m-learning producers; they have been given the opportunity

to undertake projects related to educational tools in a real environment. This article describes this experience from the perspective of the tools or apps that were created, and the benefits derived from this activity to both the students and the institution.

The second section of this article analyses the characteristics of m-learning and the challenge it poses for educational institutions; the third section describes the context of the institution within which the projects were undertaken, the student profiles and the students' m-learning needs; the fourth section presents some examples of the m-learning tools developed by the students, and describes their objectives, the technologies involved and the authors' motivations; finally, the fifth section analyses the conclusions drawn..

2. M-learning in educational institutions

Mobile learning or 'm-learning' (Naismith et al., 2004; Holzinger et al., 2005; Ally, 2009; Bachmair et al., 2010) is the term used to describe the use of mobile devices as tools in the learning process. Some strengths of m-learning are: portability, as mobile devices can be used anywhere, inside and outside the classroom; their potential as a tool for collaboration and interaction; the ability to obtain information suited to the context or situation; permanent connectivity (always on); and the possibility of adapting content to every user according to their needs and expectations.

Notable weaknesses are the limitations of mobile devices compared to computers. These include, for example, a smaller screen size, an interface that is not well suited to entering large quantities of data, or fragmentation (different manufacturers, operating systems, screen sizes, etc.). In other words, when designing an m-learning solution, not only do the pedagogical aspects need to be taken into account, but so too do the technological and usability aspects (Ally, 2005; Seong, 2006).

In the literature on the topic, a very diverse range of m-learning tools has been explored (Naismith et al., 2004), such as self-assessment questionnaires, simulations, problem-solving exercises, augmented reality guides (for museums or monuments), group work activities, and tools for personal organization (study calendars) or learning management (alert notification during the course, formality administration, etc.). In other words, m-learning tools aim to provide a response to objectives as disparate as educational content delivery, assessment, student-student and student-lecturer communication, and teaching management.

The evolution of technology has changed the landscape of m-learning proposals. For example, some early tools favoured the use of text messaging via SMS (Stone et al., 2002) or e-mail or web-browsing via WAP (Motiwalla, 2007). Today, such proposals have been totally surpassed by the availability of apps for smartphones or tablets, which can incorporate on-demand multimedia content (Özdemir, 2010), use geolocation to send data (Wang, 2004) or foster collaboration through instant messaging functions (Kukulska-Hulme, 2008).

In this article, m-learning is considered from an academic and institutional perspective, bearing in mind that the resources available for allocation to the creation or adaptation of m-learning tools are limited. It should be noted that the more sophisticated the tools are, the higher the cost of

development becomes. In addition, as mentioned already, there may be technological problems, so it is vital to ensure that every student can use the developed tools, not only at present but also in the future, to get a return on the investment made in them.

Currently, there are multiple platforms for which mobile apps are being developed, such as iOS, Android, Windows Phone, Blackberry or other cross-platform solutions based on HTML5 (Cavalas et al., 2011; Charland & Leroux, 2011). A bad choice of technology may render the investment in e-learning tools useless in the long term. For example, the use of Java 2 Micro Edition (J2ME) used to be recommended as a means of ensuring platform-independent implementation (Holzinger et al., 2005). However, the J2ME platform is no longer compatible with many new and popular devices (Gartner, 2012).

In short, educational institutions intending to commit to m-learning will need to make a considerable investment in terms of resources. Moreover, they run the undeniable risk of the investment quickly losing value owing to the technological changes taking place. Thus, it is crucial to develop a strategy to experiment with various technologies before decisively committing to them. This article aims to address that need, based on the experience of what has happened in a particular university. .

3. Context: m-learning at the UOC

The UOC (http://www.uoc.edu) is a virtual university whose mission is to offer lifelong learning, using technology as a teaching tool and a communication channel. A UOC student is someone who usually combines studying with work and/or family-related responsibilities, making it difficult for them to attend a traditional university (Duart, Salomón, & Lara, 2006). Thus, students with this profile are very motivated when it comes to using technology to overcome the barriers of non face-to-face and asynchronous learning. They are potential users of m-learning solutions.

Although the UOC is an atypical university given its virtual nature, it is nevertheless a potential point of reference for any other higher education institution. In fact, traditional universities are now offering more and more non face-to-face services through websites, online services and mobile apps. Good examples of such services are open educational resource (OER) repositories, campuses with virtual classrooms, or massive online open courses (MOOCs).

The UOC and all of these initiatives have one characteristic in common, which is crucial to the development of their projects: they need to invest in innovation and technology. Aspects like the incorporation of on-demand video, the adaptation of content to mobile devices, etc., require continuing investment. In the current context of economic crisis and limited resources, alternative ways of driving these innovative projects forward need to be found.

And this is where centers (faculties, studies or departments) specializing in engineering and technology can play a very important role. For example, in the case of the UOC, technology degrees come under Computing, Multimedia and Telecommunication Studies.

Students taking these courses have the necessary skills and knowledge to develop m-learning solutions. In addition, working on tools of this type is usually motivating for them, as they are

potential users and are familiar with the subject area and the requirements. Finally, the European Higher Education Area (EHEA) provides them with the opportunity to develop apps of this type: the final year project, an individual assignment that students must complete as a means of integrating and applying knowledge acquired in earlier years of undergraduate or graduate study.

In the case in hand, the students had the freedom to choose the topic of their final year projects and some of them put forward the idea of developing m-learning tools or services. It should be noted that having the freedom to choose the topic made the students more motivated. In addition, while the students were doing their projects, they were supervised by someone with experience (project supervisor), who was able provide them with the necessary guidance to ensure the quality of the final product. In this respect, it should be noted that the quality of some of the developed tools was outstanding, approaching that of a finished product. As a result, they were eligible for inclusion in the catalogue of teaching tools of the Virtual Campus.

For the students, undertaking a final year project related to m-learning allowed them to learn and apply their knowledge to a field (mobile technologies) that is in high demand within the labour market. In addition, being users of their own products and offering tools that might be useful to their fellow students provided them with even more motivation. From the university's perspective, projects like these represent an excellent opportunity to assess prototypes and new technologies before making any significant investment in its own apps.

4. M-learning tools born of the students' contributions

This section presents four examples of projects undertaken by the students in accordance with the proposed initiative. In order to put them into context, sub-section 4.1 gives a short description of the profiles of the students that undertook the projects. Sub-section 4.2 gives details of their objectives and technical characteristics. Finally, sub-section 4.3 summarizes the students' future expectations for the developed apps.

4.1 Student profiles: motivation and prior training

The profiles of the students that performed the function of m-learning producers were diverse. Regarding their prior knowledge of app development for m-learning environments, it should be noted that some of the students were self-taught: from those who had become interested in the topic several years beforehand to those who had taken a tutorial or a specific, one-off course. In contrast, others had no prior training in this respect. Only one student had a purely professional interest.

All of them were very attracted to the topic, either because they had recognized that this technology was cutting-edge and of considerable interest, or having identified certain limitations in relation to the learning environments and the use of mobile devices, had been unable to find apps or tools to meet their needs. For example, despite having electronic devices like an iPad available, one of

the students was unable to study if he/she was not in front of a computer. Another, who wanted to learn Japanese, had looked for all sorts of mobile device apps but found that they all had significant limitations. In the first case, the student chose to design a tool from scratch, and in the second, the student developed a tool that would not have the limitations identified in the existing ones.

In the majority of cases, the challenge was lifelong learning for mobile environments through the creation of an app that would be useful to the person developing it and to others as well.

4.2 Final year project descriptions

Described in detail below are the four projects undertaken by these students in the sphere of e-learning. Table 1 summarizes their main characteristics:

Table 1. Summary of projects presented

	LiveUOC	*iUOC*	*Language Learning*	*Mprogcourse*
Objective	To enable access to the Virtual Campus (e-mail, forums and activities)	To enable access to the Virtual Campus (e-mail, resources and activities)	To enable learning of Japanese Kanji symbols	To enable subject monitoring (activities, resources and events)
Platform	Android	iOS	Cross-platform (HTML5)	Cross-platform (HTML5)
Architecture	Client	Client	Client-Server	Client
Technologies	Android, Java and JSON	iOS (XCode, ObjectiveC) and JSON	Sencha Touch 2, Apache Tomcat, J2EE, MongoDB, HTML and CSS	Phonegap, JQuery Mobile, HTML and CSS
API used	OpenAPI (LTI)	OpenAPI (OAuth2)	--	Gmail and Dropbox

4.2.1 LiveUOC

The LiveUOC project (Serrano, 2012) developed an interface for Android devices to enable access to the UOC Virtual Campus (see Figure 1). This interface allowed people to identify themselves as Virtual Campus users, to access personal e-mail and check message boards, discussion forums and activity calendars in the virtual classrooms.

The technologies used in this project were Android (the platform), Java (the programming language) and JSON (the data exchange mechanism). In order to perform these tasks, the mobile app also interacted with the Virtual Campus via an API, which provided identity and messaging services, etc., in accordance with the LTI 1.1 standard (IMS, 2012).

It should be noted that the project was developed before the first corporate app for mobile access to the Virtual Campus. The app therefore allowed the challenges of delivering some of the Virtual Campus services via mobile devices to be explored and the usability of a simple mobile interface to be tested.

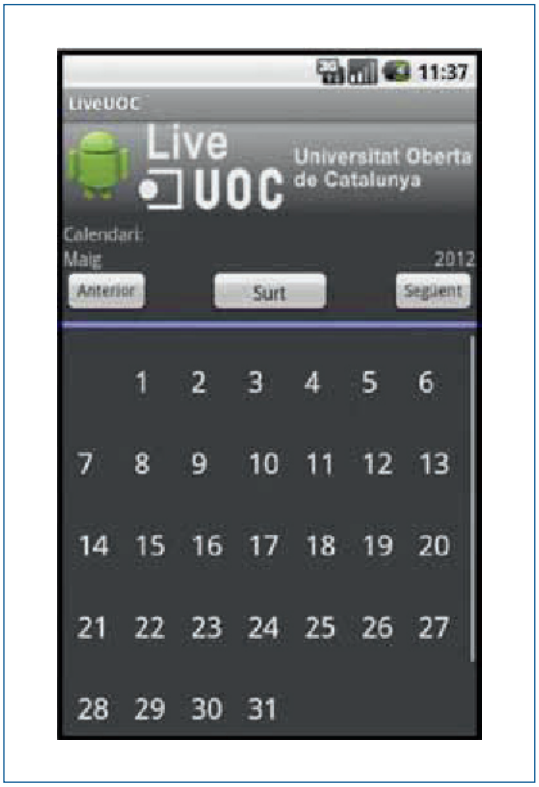

Figure 1. Image of the LiveUOC app

4.2.2 iUOC

The iUOC project (Fernández, 2013) developed a mobile interface for iPads to enable access to the UOC Virtual Campus. The app allowed users to be authenticated on the Virtual Campus and to access and download course-related documents. Finally, the app provided users with the option of viewing the assessment activities of the subjects in which they were enrolled.

This project used technologies associated with development for the iOS operating system (Objective C, the programming language, and XCode, the development environment) and JSON (the data exchange mechanism). In order to perform these tasks, the mobile app also interacted with the Virtual Campus via an API called OpenAPI (Rius et al., 2012) based on the OAuth2 protocol.

Besides the resultant app, this student offered the library developed in the course of the project, which connects to the OpenAPI, to the UOC in order to facilitate the development of more advanced apps. Likewise, the student offered an open source code version of it, having developed it free-of-charge for the institution; the student reserved the full version in order to offer it to the general public in an app marketplace.

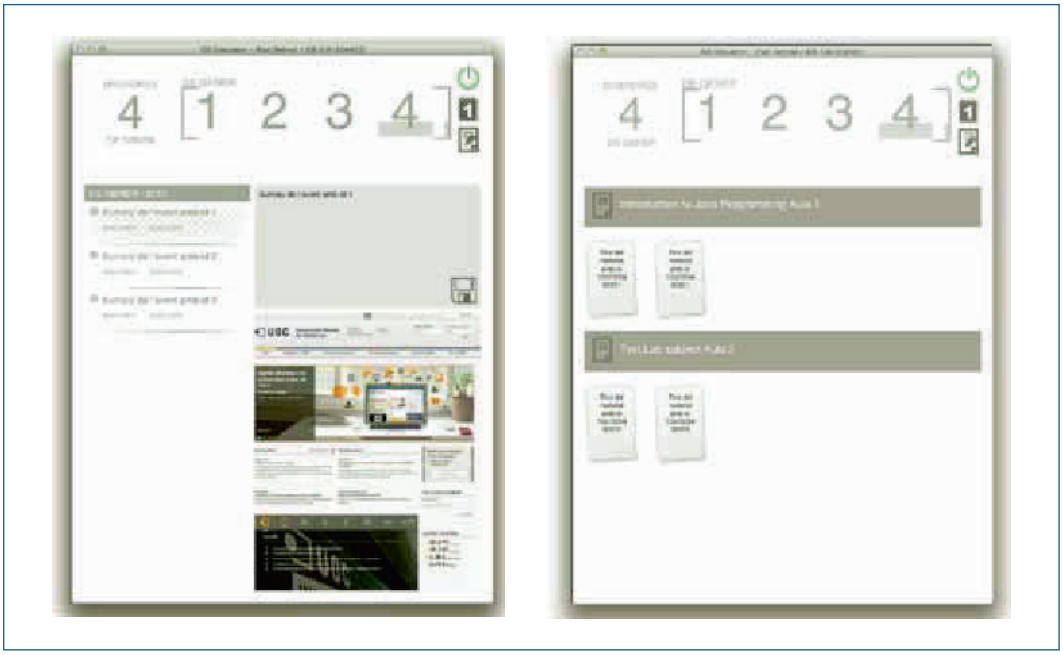

Figure 2. Screenshots of the iUOC app interface

4.2.3 Language Learning

The Language Learning project (Capell & Lorca, 2013) developed a client-server app to enable learning of the Japanese language Kanji alphabet. The app had a dictionary of words displayed in the form of flashcards to facilitate memorization. In addition, users had the option of sorting their lists of words by topics (days of the week, food, etc.) to guide study.

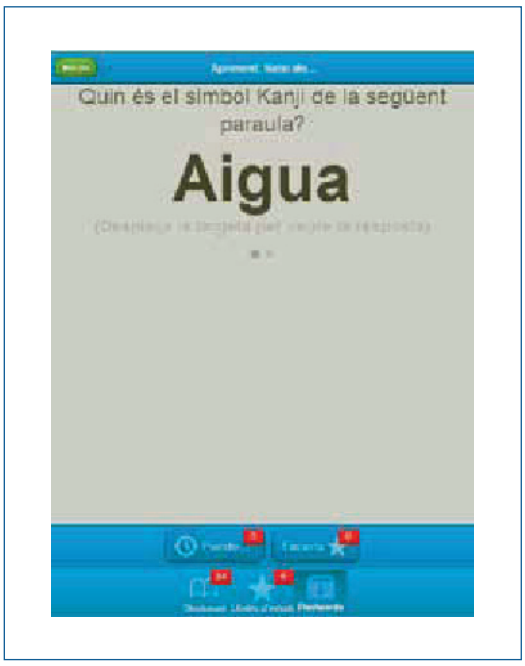

Figure 3. Screenshot of the Language Learning app interface

The project used the Sencha Touch 2 framework (for cross-platform development based on HTML5), Apache Tomcat (the app server), J2EE (for server development) and MongoDB (the database). The resultant source code had an open source license and was saved on the GitHub website to facilitate collaborative development.

It should be noted that this project was undertaken collaboratively by two students. The work was divided up according to the planned functionality: one student undertook the server part and the other undertook the client part for the data display. A joint project between two students can be a risky venture because, if one drops out, they both suffer. However, if they succeed in working together, then the teamwork competencies are considerably strengthened, as was the case in this instance. In this project in particular, one of the students did not have any experience in mobile app development, and he/she compensated for his/her lack experience with a self-teaching attitude and remarkable dedication. The implemented tool was fully functional and both students asserted that, owing to its modular structure, it had been designed to be easily extensible. They planned to make the app freely available to the general public in an app marketplace at some time in the future.

4.2.4 Mprogcourse

The Mprogcourse (Rodríguez, 2013) project implemented a tool to enable academic courses to be monitored; it displayed practical information to enable course monitoring. In particular, the project allowed a classroom to be simulated, where, using their mobile phones or tablets, students could access course-related documents or resources and the adjunct lecturers' curricula, receive notifications in accordance with the course calendar and access the geographical location of course-related events.

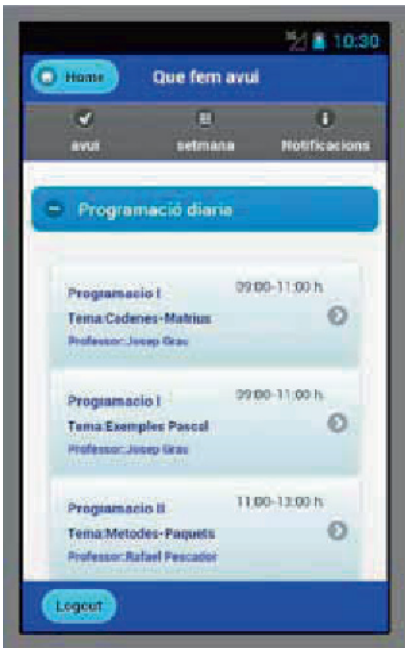

Figure 4. Mprogcourse app interface

The technologies used in this project were Phonegap and JQuery Mobile (for development based on HTML5), the Dropbox API (for user authentication and file download) and the Google Maps API (to display maps and event locations).

4.3 Continuity expectations

On completion of their projects, the students felt very motivated by the results obtained and satisfied with what they had learnt during the process. They also remained interested in the idea of continuing to develop the apps produced in the course of their projects:

- Three planned to make the apps freely available to the general public in an app marketplace (App Store, Google Play, etc.).
- One had published his/her app with an open source license.
- Another was working on a new app based on a future line of work identified during the project.

However, at the time of writing, only one of the projects (Language Learning) was being assessed for potential use in a subject. In this respect, one of the challenges for the institution is to ensure that the efforts that the students put into these apps can have a positive impact on the faculty. Thus, for example, the following features can be promoted:

- The use of open source licenses on such apps.
- The use of institutional repositories for app storage.
- The collaboration of the university's teaching staff and managerial staff while these projects are being developed to provide guidance on the expected outcomes and ensure that the knowledge acquired in each project is not lost, but instead remains within the institution.

In this respect, it is important to highlight the enormous diversity of technologies explored by the students in their projects. Even if the end product cannot be directly exploited, the knowledge acquired about the suitability, level of maturity and tools available in the various environments is very valuable to the institution when it comes to developing its m-learning policy.

5. Conclusions

This article presented an institutional approach, within the university sphere, of undertaking final year projects whose end products could be of benefit to the institution. The objective was two-fold: first and foremost, to train students on the topic of designing and applying mobile device programs, and second, to provide them with the necessary background to ensure that the products obtained would be useful within the university's own m-learning context.

The preliminary results of applying this new process to final year projects were satisfactory with respect to both student outcomes and community creation. Regarding the former, the students acquired mobile development and usability competencies and demonstrated a high level of engagement (because the results of their work would be useful to their fellow students). Concerning the latter, it has already enabled some of the new mobile tools to be incorporated into the Virtual Campus. Furthermore, the use of open source code in the described approach allows new apps to be developed by building on the results obtained in earlier projects, as well as adding functionalities to mobile apps that have already been developed.

The results obtained may help other institutions to follow a similar protocol in their face-to-face and virtual teaching. However, educational institutions that want to engage their students in the development of m-learning apps will face two challenges:

- Reducing the barrier to entry: students interested in developing new apps must be given facilities to do so. In this respect, a potential strategy would be the creation of an open API to enable access to a university's services and IT systems in a controlled, simple way (Rius et al., 2012).
- Gathering and disseminating the results of these apps so that future projects can use, expand and improve them. In this respect, it is crucial to have a catalogue of apps produced (for example, http://open-apps.uoc.edu/index.php/en/) to facilitate their re-use and expansion. In other words, it should not only include the final app, but also the user manuals, design documents, source code, etc.

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