

Training Oriented Mobile Device to Learn Software Architecture

Mostadi Sanae

Ecole Supérieure d'Informatique Appliquée à la Gestion
ESIAG, UPEC University
Créteil, France
mostadis@miage.u-pec.fr

Mourlin Fabrice

Algorithmic, Complexity and Logic Laboratory
LACL, UPEC University
Créteil, France
fabrice.mourlin@u-pec.fr

Abstract—Teaching new technologies has two facets. A first facet is the pleasure to discover new concepts with beginners. The second facet is the difficulty to create the right training for students who will apply this knowledge through an internship by the end of the training. Since January 2013, our challenge has been to prepare a new training about nomadic device and Android programming. Our training is structured as a master's degree in our UPEC University (Paris). This document presents both aspects of this master degree: the construction of the training and the perception of teaching activities by the students. We observe that the use of a tablet or a smart phone during the lessons is not enough. Pragmatic approach is limited even if it is a help for the participation of students, and a motivation for teachers and students in a computer science context where it is crucial to explore new domains. Learning with device provides a more practical teaching. But its use has to be completed by knowledge validation with it. Because devices take place into teaching approach, the whole process of teaching has to evolve into a more interactive exchange between teachers and students.

Keywords-mobile device; distributed system; software architecture; teaching mobility.

I. INTRODUCTION

Software systems become more and more complex and now new devices have to be taken into account. Smart phones and tablets bring a new software facet: the mobility. A more accurate word would be nomadism [1], because, it allows users to exploit software applications during a movement between two locations. Mobile devices [2] can further be defined as having the ability to receive and/or transmit voice, text, data, messages and/or Internet usage without a cable connection. Also new application domains can be sketched. For instance, the use of mobile devices allows photograph and record public information and transfer data easily with a timestamp.

These new features involve new difficulties, and the need of training appears more and more essential. Previous example introduces the need to store data locally to a device, they need to exchange data over the network. Also, it appears today that a tablet or a smart phone does not support the same kind of software [3][4]. A database server cannot be installed on such device, neither a mail server. Also, applications on mobile devices are often client application of remote services which are implemented on more traditional servers. The important concept is the available binding for the exchange.

This highlights that mobile devices provide a plethora of possibilities for sensitive information to be accidentally leaked into the public. It includes local data, pictures, text messages, phone numbers, permissions, and more. Again, the need of security management seems to be crucial.

Mobile technology is now being used in classrooms. Also, it seems natural to offer basic to advanced instructional mobile technology training for students. It appears clearly that mobile technology encourages creativity and hands-on learning with features not found in any other educational tool, on a device that students really want to use. From this, we have created a series of lessons around mobile technologies. The first year allows us to have the first results presented in this document.

We present our work as follows. A first section is about the training creation process and how we have built a training oriented device (TOD). The next section is on the role of the mobile device during the courses: its impact on the teaching and also on the work of the students. Next, we detail our results during the academic year and the process of internship selection. Finally, we propose a new objective for the next academic year and the consequence on our teaching approach.

II. TRAINING CREATION PROCESS

Mobile devices are becoming increasingly valuable within the computer science teacher community for both training and concrete applications [5]. So, our teaching team was ready to use tablets for presentation. Each teacher had bought his own portable tool and appreciated his own choice because of its instant feedback, its large selection of applications or the wire free teaching. Our approach to creating computer training required to choose a material to support all the teachings. Next, we present our criteria and how they were validated.

A. Material selection

Creating training with mobile device does not always mean eLearning. In our context, this creation for display on mobile devices involves handling different mobile platforms, designing appropriate content and adapting existing content for different classes of devices. Also, a kind of tablet should be selected before the start of the academic year (September in France). A family of criteria was enumerated by the teachers. There was reliability, an enjoyable interface, the energy efficiency, a camera, remote monitoring, and so on.

We classified these criteria into three classes: the criteria required by the teachings, the criteria required for students, the criteria required by the Institute [6].

1) *The criteria required by the teachings:* tablets are highly portable, touch screen, Internet enabled, handheld computers. These basic features are common to a set of material, but additional features are required for our teachings. First, the wireless network course requires that the equipment has the capacity for Bluetooth, WIFI, but also connections between other USB type (version 2). Next, Android programming course requires to install a version greater than 4.2 because the graphical user interface toolkit is richer and bugs were fixed. In particular, drawing is optimized for layers, clipping and certain shapes. Next, the system course presents the management of sensor, camera and Near Field Communication (NFC) hardware interface.

2) *Tablets vary in the way they organize the screen layout.* The 4:3 aspects are more suited to being used in portrait mode and this is why the home buttons are positioned for that orientation of use. The 10" category is a good size device. Teachers should also consider using larger devices where possible, especially if they are using classroom management software and have a lot of information on their screens at any one time.

3) *The criteria required for students:* during the academic year, the students have to prepare presentations where the mobile device is important. To make it easy to show content on an external display, the device has to provide a special ability to render the content of a screen according to the characteristics of the targeted display. Moreover, the students need to exchange data between tablets or between a tablet and other Bluetooth devices. Also, the Bluetooth stack implementation version is as important as the Java Application Programming Interface (API). Each student has to develop Java applications and it could be suitable to have a rapid access to all need sensors through a Java API.

4) *The criteria required by the Institute:* The management of devices is not trivial in an academic institute. Especially, when problems occur, such as a breakdown, a process of repairing has to be subscribed before. Also, it is interesting to have only one kind of tablet for all the students of the master degree. Moreover, the tablet was given to a student for the duration of the school year and students are asked to pledge in writing. So, everyone should be responsible for his actions. The budget was also one of our primary concerns and the Android option was preferred because the prices are also affordable, even if the number of tablets was more than twenty. Google education packages are another feature which supports the choice of such kind of tablet where teaching applications are available.

B. Training plan construction

At the beginning, our training goal was to provide training to master students on the mobile device. The trainees will learn skills on the programming and management aspects of mobile devices and how to set and run the applications.

1) *The objectives of the training:* we wanted to train our students on a new skill (mobile programming) and to refresh them on things which they already knew such as distributed architecture. After the master degree, our students will have to easily find mobile application development jobs. Jobs for mobile application developers are at an all-time high and continue to show no sign of slowing down. This means that we defined courses adapted to the market. We will be going to assess if the training has met its objectives, whether the internships are success and students have future first jobs.

2) *People who are going to train:* The trainees are new students, which means they will be learning a whole new skill set. They come from other universities and some of them come from other countries where training organization respects other rules. Because students have to work together, they also have to learn how to work in project mode. This means developing responsible and autonomous learners. The teachers are frustrated by their unmotivated students. But what they may not know is how important the connection is between student motivation and self-determination. Mobile programming is considered in a positive manner by new students. Their mobile smart phone or tablet is the mirror of what they are. Also, they consider as an identification, the knowledge of the mobile device. This is their connection point of social networks, also the motivation is deep.

3) *Material suitable for the trainings:* the iteration of our criteria helps us to select Android devices from several constructors. We did three kinds of tests:

a) *Robustness:* this is the degree to which a device operates correctly in the presence of exceptional inputs or stressful environmental conditions [7]. We have run a set of applications which need to use the WIFI connection or Bluetooth protocols. We have used external device: *Secure Digital* (SD) Card and USB connections, the impact of multi connections on the efficiency. Finally, we have validated the multi touch screen and its behavior depending on the size, the precision [8].

b) *Technical capacity :* Benchmarking applications are useful for measuring the performance of mobile devices and comparing the scores with similar devices. We have defined three benchmarking applications for Android devices that we used to see how the device measures up [9][10]. They test the performance of processors, graphics systems, Web browsing, and more.

- Quadrant Standard Edition (QSE) tests CPU, I/O, and 3D graphics. After running through the tests, we have been required to submit the score to the

company's servers in order to see the results. The bar chart shows our overall score and compares it with other devices.

- Linpack is a benchmark that's been used to measure the CPU performance of some of the world's fastest computers. We have used the same benchmark to test all Android tablets. The final score is given in Million Floating Point Operations Per Second (MFLOPS) and is a quick and simple test of the device's performance.
- Vellamo measures the Web browsing performance of Android devices in 4 categories--rendering, javascript, user experience, and networking. It also checks the ability to request and to respond to servers.

All the applications mentioned above are free from the Android Market.

c) *Simplicity*: Tablets now provide continuing advances in our search for simplicity of use. They have to allow developers to create simple ways to do things. We have checked the automatic plug and play through USB connection. But the control is also on the recognition into applications. For instance, developers use Eclipse *integrated development environment* (IDE) for programming and debugging. For tablets it is necessary to restart the platform server, for others it was automatic.

4) *The kind of training*: There are many factors when choosing a course of study or training. We have the traditional training style where the focus is on the teacher and the training session is very much content-driven. In this style, we say that the learning depends on a teacher. The use of mobile device involves the introduction a new facilitator style of learning that is focused on the learner. This style is process-driven and the learning takes place independently, without the teacher. A key to motivating students is helping them to see that, indeed they can take responsibility for their own learning. So, a part of each lesson is letting students work together with other students to meet learning goals. Also, we have defined three learning mode:

- Traditional learning mode: this corresponds to the first part of each lesson.
- Facilitative learning mode: the second part of the lesson where students have a responsibility to apply what they have previously learned. This mode also applies during project option where students work in group.
- Programmatic learning mode: the last part of the academic year is a six month internship. The students are in a more concrete context where their skill can be validated by results.

5) *The schedule over the year*: The academic year is divided in half. The first half has mainly courses and the start of the project option. The second half contains an important place in the project option and ends with the

internship. We have scheduled the first part of the year as follows:

- Project management course
- Methodology and functional specifications writing
- Architecture and drafting of technical specifications.
- Web architecture for nomadism,
- Performance evaluation,
- Change management,
- Computer science law,
- Databases for mobile device,
- System and network programming for mobile,
- Programming for mobile phone and tablet,
- Mobile networks and wireless networks,
- First part of project option,

The second part of the academic year is divided as follows:

- Software engineering,
- Business simulation,
- Design patterns for web applications,
- Mobile architecture for cloud,
- Security policy,
- Performance and quality of service,
- Last part of project option
- Internship thesis,

The scheduling of the course is to adapt best to the project option. Traditional teachings stop in April. Then, the internship begins; in parallel, the project option continues. At the end of June, students have to validate their project option. The defense of internship leads to a probation report and an oral presentation in early September.

6) *Transforming the plan into actions*:

When the training plan was built, the next actions were the construction of the list of concerns per lesson. This is done by the person responsible for training. The aim is to validate that:

- There is no overlap between training.
- The number of lessons is enough for the list of concerns.

The next actions were the construction of the activities per lesson. Because concern is presented to the student during the first part of the lesson, then they have to practice. So, pragmatic activity has to be prepared with the material (mobile device). This allows the teacher to measure useful time to realize this activity and the material constraints which are required.

C. *Validation plan*

In the evaluation phase, we will determine if the students obtained the knowledge, skills, or attitudes we identified as the goal during the analysis phase. Using the information we will obtain during the evaluation phase, we will make additional changes to the design, development, and delivery of the training program the next academic year we offer it to students. The assessment validation provides assessors with an opportunity to:

- Evaluate the technical quality of the training and assessment tools being used,

- Develop some benchmark performances,
- Discuss issues of concern about the training delivery and assessment process,
- Suggest improvements for training delivery processes and assessment tool design.

The validation plan is the process of determining that our requirements are the correct requirements and that they form a complete set of initial requirements. This will have consequences on the next student selection.

III. DEVICE IMPACT INTO TRAININGS

The technology constantly changes; if we incorporate technology in our master degree, it is imperative for us and our students to be current.

A. Tablet role into lesson

A student is unlikely to master new technology on his own accord. For this reason, we have incorporated mobile technology training in the classroom. Also, we have included mobile software applications to help facilitate or organize the work's tasks. First, tablet is the support for the course called "Programming for mobile phone and tablet". This means that developments are realized on the laptop and experimentation is done on the tablets. This course provides an overview of the most common programming environments for mobile phones and students learn how to program on mobile devices. The teacher can validate that experimentations are really done. By small examples and hand-on sessions, students are able to create their own applications. Besides the general overview, focus is on networking issues with mobile devices. Besides simple client/server examples, also peer to peer networks are discussed by the teacher.

The course called "Web architecture for nomadism" is built to explain how mobile devices running Android can be incorporated in Web architectures. The web is evolving very fast to provide the same functionality to web-apps that standard desktop applications have. Students have to develop Web activities using standard web technologies as much as possible on their own mobile device. For example, a case of study is to take a picture from the device camera, and that is possible with web standards. Then, the mobile application uploads the image onto a web server by the use of Representational State Transfer (REST) service.

Other experimentations are done in the course called "Databases for mobile device". Mobile databases, like sqlite are popular because mobile devices have become need based and common. One key aspect of these database systems is their ability to deal with disconnection. We experiment Extensible Markup Language (XML) graph database on the tablet. Through a lesson, the teacher explains when the device is not protected properly all the data stored in the device are exposed to outsiders. So, security for the database that resides on the mobile device is crucial for organizations. Also security concerns are introduced by the end of the course.

During the course entitled "Mobile networks and wireless networks", protocol exchanges are studied. Also, students have to understand how a mobile device communicates with other devices even if it is moving from one location to

another one. The teacher explains network physical layer communications; those advanced electromagnetic lessons give the scientific foundation for wireless communications. Then, physical exchanges of data are filtered by the use of packet analyzer. Practical experiments show that negotiation algorithm can be set between two devices or more in a local area.

B. Tablet role into project option

The project option is a teaching which consists of lectures, meetings and labs: each module provides 36 hours of lectures and meetings, supported by labs and directed further study. There are eight taught modules. Their names belong to the list of courses given in the previous section), four per semester. From the end of the exam period, students will be fully engaged in their summer project, which is equivalent to another four modules.

1) Presentation of the project option:

For the projects, students have the opportunity to engage with: Software Architecture, Complex Networks, Workflow, Business Process and the Internet of Things. They have access to licensed software tools, e.g., Fuse *Enterprise Service Bus* (ESB), Tao ORB, and access to commercial network operating systems.

The project is based on the realization of a distributed project where clients run on mobile devices. This year, the topic of the project is to achieve an application for a telecommunication operator offering its customers access to fixed telephone networks, mobile phone, and Internet (data, image, voices). This telecommunications company operates nationwide through the operation of a full infrastructure: antennas, splitters, hubs, routers, controllers, etc. It also sells or provides to its customer terminal equipment (mobile and fixed phones, box) [see Fig. 1]. It also has monitoring centers, which allows him to oversee all activity on these networks and to intervene in case of failure or degradation of service as well as many administrative and technical departments to ensure all of the services offered to its clients.

The company might be interested in the proposed student project solution if it has the required physical infrastructure, but lacks software coupled with the enterprise information system. The purpose of this project is to create a modern information system for such use. The potential customer has the following objectives:

- Positioning as a major player in the Cloud
- Converging data from different networks are integrating the new mobility
- Access the Cloud in multichannel
- Integrating B-to-B offering a solution tailored to the needs of each
- Ensure the customers the validity of the software solutions through the use of a dynamic environment and equipped simulation.

2) Project functionalities

The project offers subscribers an online portal. As a mobile operator, it offers its customers a mobile application that allows direct access to the functions of the portal, except access to Webmail. One example is consultation mobile account access to invoices. The operator hopes that this

As shown in Figure 1, SGW (Serving Gateway) equipment is intended for packet routing between the eNodeB and a data network such as IP network. PDN GW (Packet Data Network Gateway) meanwhile it provides the direct interface between the Long Term Evolution (LTE) network (4G) and the Internet network or Session Initiation Protocol SIP-based networks.

3) Software architecture

Most cut into thirds architectures based on service-oriented backend. These services are masked by the GUI, intermediary services, and online applications. However, these services often have business logic. Access to these services Backend is made possible through the common protocols used in the world of Web: *Simple Object Access Protocol* (SOAP), REST, etc. [11].

Computer Internet or PC (Mac / Linux) differs from mobile computing. The screen size, connectivity, energy saving drives, software to provide dedicated mobile terminal applications. When an application is available online, it is also via a special mobile browser. Airworthiness becomes smaller by the nature of the mobile terminal. That's why publishers often offer a dedicated application. The case is the same for PC applications (Mac / Linux).

The realization of the project is based on object implementation using software architectures known models (design patterns, *model-view-controller* (MVC), DAO, Singleton, Decorator, etc.). The implementations permit to decouple application components to make the technical aspects of modular software. Each program must be delivered manageable. Or it can be configured itself (through its menus, loading options) or through programs (or applications) Administration (configuration).

C. Tablet role in student life

The use of a tablet in school as extra-school is perceived by students as an asset. It is a way to communicate on social networks. It also offers the opportunity to better prepare their future jobs.

In addition, students use mainly for doing all kinds of searches: cinema, show, address, they use it mainly to check their e-mails. Finally, they use it mainly to watch the video and / or listen to music. Some video tutorials are directly related to the project option.

IV. RESULTS OF OUR TEACHING APPROACH

If the touch pads do not replace completely the computers, they enrich the teaching strategies used by teachers and the learning of their students, with shades depending on the levels and objectives. Rapid implementation, autonomy, lightness, ease of use, mobility is known qualities to change the organization and use of digital technology in the classroom. The tablet provides the flexibility of the duration and frequency of sessions. The tablet is on the table, next to the book, the book and the kit can be used at any time for a consultation exercise, a recording, a work of individual or collective research, even

for an activity short. It is one tool among others and fits naturally in a conventional teaching session.

This type of tool allows the student to alternate easily between individual work and group work. Individual work produced by the student or by a group of students on a tablet is projected on the board and is subject to analysis, discussion and collective changes. Trade shares, confrontations, conjectures, many processes that facilitate or strongly boost the development activity and student participation. The tablet is the complement of digital interactive whiteboard in digital class. It helps to make a coherent and enhances its effectiveness.

In addition, there are a variety of educational activities related to the specific contributions of the tablet. The multi-sensory aspect makes it a more suitable tool computer to pupils with special educational needs. It allows renewed in disciplines related to the interaction creativity. It changes the status of the writing of the book.

The tablet allows the students to associate reading and writing facilitated by circulating between consultation, comments and exchanges, but also to play with the image and sound - especially for repeat presentation. It facilitates access to multiple resources such as numerous works (simply stored and maintained on the machine or made available from specialized servers). The recording and playback feature makes the tablet a little language laboratory. Cameras and cameras are used in many occasions (during oral expression) to produce reports meeting work. Mobility also opens uses far impossible to consider. It fundamentally changes the attitude and student learning strategy in computer science courses and other disciplines.

V. CONCLUSION AND FUTURE WORK

After a first quarterly study, we are convinced of the value of our teaching approach. We have shown in this paper that the contribution of the tablet is the undeniable motivation of the students but also their investment at work. This is seen especially for the project option which uses the tablet in multiple ways. Finally, the satisfaction of having a specific tool for their training, provide students a motivation of success. We mentioned in our feedback, the role of tablets in the preparation of presentations, analysis workshops.

We intend to continue our approach by exploiting further use beyond tablet. In fact, all teachers do not have sufficient supplies to meet the demands of students. Also, for the next school year, we would to set up dedicated software for the exchange student teachers, based on a multi-channel communication medium. We are currently in the process of defining needs and we are looking forward to prepare for the 2014 school year.

REFERENCES

- [1] J. RL. Lieffers, A. V. Vivienne, and M. H. Rhona. "Use of Mobile Device Applications in Canadian Dietetic Practice." *Canadian Journal of Dietetic Practice and Research* 75.1 2014, pp. 41-47.

- [2] C. Yin, B. David, and R. Chalon. "Use your mobile computing devices to learn-Contextual mobile learning system design and case studies." Computer Science and Information Technology, IEEE, 2009. pp. 440-444.
- [3] Y. M. Juntao. "Enterprise J2ME: developing mobile Java applications. Prentice Hall Professional", 2004.
- [4] Ed. Burnette, Hello, "Android: introducing Google's mobile development platform. Pragmatic Bookshelf", 2009.
- [5] Wasserman, Tony. "Software engineering issues for mobile application development." *FoSER 2010*, 2010.
- [6] D. L. Kirkpatrick and J. D. Kirkpatrick, "Evaluating training programs: The four levels." Barrett-Koehler Publishers. 2006
- [7] M. Silberman. "Active training: A handbook of techniques, designs, case examples and tips." San Francisco: Pfeiffer, John Wiley and Sons, Inc. 2006
- [8] Z. Micskei, et al. "Robustness Testing Techniques and Tools." Resilience Assessment and Evaluation of Computing Systems. Springer Berlin Heidelberg, 2012. pp. 323-339.
- [9] P. Koopman, D. Kobey and D. John. "Interface Robustness Testing: Experience and Lessons Learned from the Ballista Project." Dependability Benchmarking for Computer Systems 72, 2008, pp. 201.
- [10] R. L. Linn, E. L. Baker and S. B. Dunbar. "Complex, performance-based assessment: Expectations and validation criteria." Educational Researcher, 20(8), 1991, pp. 15–21.
- [11] L. Richardson and S. Ruby. "Restful Web Services." O'Reilly Media, Inc, May 2007.
- [12] F. Kuhn, N. Lynch and R. Oshman. "Distributed computation in dynamic networks." the 42nd ACM symposium on Theory of computing. ACM, 2010. pp. 513-522.
- [13] R. Allen and D. Garlan, "A formal approach to software architectures," in Proceedings of IFIP'92 Elsevier Science Publishers B.V., September 1992.