

# Maputo Living Lab Summer School of ICTs: an Experience Report

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**Abstract:** This paper presents our experience with the organization of the Summer School of ICTs (SSICT) of Maputo Living Lab. SSICT is a free 1-month course for 3<sup>rd</sup> and 4<sup>th</sup> year undergraduate students that provides practical training on the management, design and development of software projects that can have an impact on the local society. The School has been organized for 2 editions in 2011 and 2012 in Maputo, Mozambique and it is part of the larger Maputo Living Lab project.

**Keywords:** living labs, computer science, education, Mozambique

## 1 Introduction

Fostering education in ICT is considered by many ICT for development scholars and practitioners as an effective way to stimulate entrepreneurship, innovation and – in general – socioeconomic development in emerging economies [1][2][3].

The initiative presented in this paper is part of a broader Living Lab project started in January 2011 in Mozambique [4]. The goal of the project is to activate education, research and innovation activities centered around ICT4D applications in the area of Maputo and in the rest of the country. Considering the distributed nature of Maputo Living Lab, education and mobility have been part of its agenda since its inception and have been considered as the primary way to build capacity and train local computer science graduates with practical and development oriented skills.

Similar initiatives are being conducted successfully all across Africa and the developing world with different target audiences, providing basic computer literacy training in most of the cases but also providing more advanced skill sets to potential ICT entrepreneurs. See for example the initiatives developed in Tanzania and described in [5] and the ZanziCode course promoted by the NGO ICT4D.at in Zanzibar<sup>1</sup>.

In this paper we present the Summer School of ICTs of Maputo Living Lab, a 1 month hands-on course for 3<sup>rd</sup>/4<sup>th</sup> year undergraduate university students aimed at providing training on software project management and development using widely used technologies (Java, Java EE, Android). Two editions have already been successfully concluded, with a total of more than 50 participants from 8 different universities of Maputo and Quelimane. After completing the course, some of the students were embedded in the Maputo Living Lab and participated to later projects.

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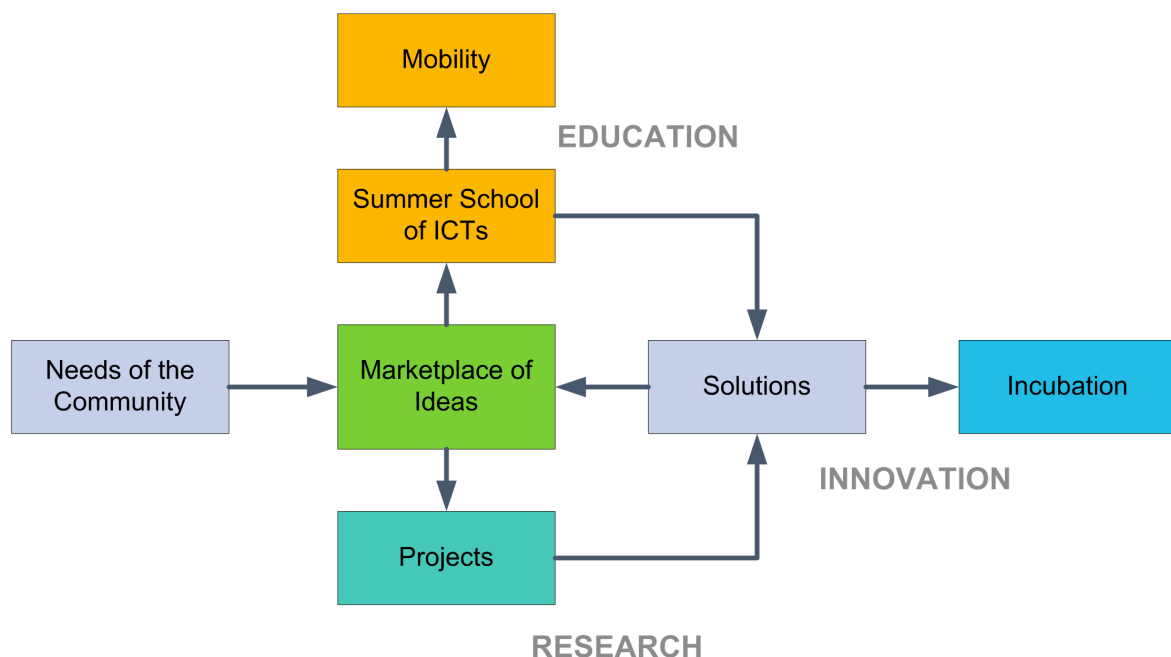
<sup>1</sup> <http://zanzicode.com>

The Summer School is organized on a yearly basis. The 2011 edition was held in November with 26 students from 7 different universities and different backgrounds and the second edition was held in July 2012 with 25 students. Participation was completely free of charge. The school was extremely interactive and stimulating for the students, who worked on a real projects for managing vaccination records (supported by the Ministry of Health) and for providing extension workers with agricultural market information. In December 2011, a small group of the same students collaborated remotely with a group from Trento at the Random Hacks of Kindness Global Hackathon and a group of students from the first edition participated to the SAMo project in June 2012 (funded by the World Bank). The best students of each edition of the Summer School were selected to be awarded grants for internships and master courses in Trento and at local ICT companies.

This paper presents the experience of the first two editions of the Summer School by describing their syllabus and the approach adopted. The discussion then presents our findings and outcomes to conclude with an outline of the future development of the initiative. The paper is structured as follows: Section 2 describes the context of the Summer School and summarizes the goals and operating model of Maputo Living Lab, Section 3 presents the objectives of the Summer School, Section 4 provides details of the approach adopted for teaching and the syllabus taught during the first two editions, Section 5 illustrates the lessons learned along with the follow up activities planned for the next editions. Section 6 envisages the future developments of the Summer School and portraits a possible expansion of scope of the initiative. Finally, Section 7 draws the conclusions of the discussion.

## 2 Context: Maputo Living Lab

The Summer School of ICT is organized as one of the core activities of Maputo Living Lab (MLL) [4]. MLL is a Living Lab project funded by a technology cooperation agreement signed between the Government of Mozambique and the Province of Trento, Italy, which is providing the funding to cover the initial operations (2011 – 2013). Maputo Living Lab aims at improving competences, stimulate development through the use of ICT and ultimately support entrepreneurship at community level, launch joint ventures and attract international investments in ICT for development projects in Mozambique.



*Figure 1: Maputo Living Lab operational model*

The activities of MLL involve Fondazione Bruno Kessler, the University of Trento, TasLab<sup>2</sup> and GPI as primary Italian partners. The Ministry of Science and Technology and the Mozambique Information and Communication Technology Institute (MICTI) are the primary Mozambican partners. The core activities of the project are:

- Development of applications and research projects focused on services for rural areas aligned with national priorities.
- Incubation to support start-up companies and facilitate spin-off entities developing products and services based on local requirements.
- Training, internships and students mobility.
- Exchanges of researchers and ICT practitioners between Mozambique and Trentino.

The joint operational committee incorporates a representative from TasLab, Fondazione Bruno Kessler and the University of Trento and three representatives of the Ministry of Science and Technology in Mozambique. This committee is supported by a working group in each country, who work together as a virtual team to implement the project and knowledge transfer. Presently, the team in Maputo is composed of a director, 3 staff members with ICT expertise and a group of former students that have been embedded in MLL as project developers.

### **3 Objectives**

The Summer School of ICTs (SSICT) aims at training university level students in computer science with the know-how necessary to plan and develop projects relevant for improving the quality of life in the impoverished areas of the Mozambique. All in all, the SSICT has three main goals:

- Build groups of motivated people that work on ICT4D projects at MLL addressing national issues.
- Create agile teams that can start companies and find potential for reverse innovation, stimulating cooperation between the Education-Research-Innovation systems of Italy and Mozambique.
- Build a reference practical course of ICT to enable local students to quickly develop internationally competitive and recognized skills.

With these goals in mind, we developed a compressed syllabus to give 3<sup>rd</sup> and 4<sup>th</sup> year students a practical perspective on software projects. Such syllabus, described more in depth in the next section, is focused on practical activities, agile software development and open discussion. This is extremely innovative from the perspective of the attendees who are mainly used to theoretical and frontal teaching but at the same time it presents several challenges described in the subsequent sections.

### **4 Approach and Syllabus**

The Summer School is a 4 weeks course, delivered completely free of charge by instructors from different Italian and Mozambican institutions for a total of 100 net hours. It focuses on hands-on training and on giving practical skills and competences; the school is independent

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<sup>2</sup> <http://ptl.taslab.eu/iniziativa>

from any University course and it does not provide formal credits to the participants, since this is not the main goal of the school. Lessons are given daily in the morning of weekdays.

The SSICT is organized around a project to develop a specification and a prototype of an ICT solution targeting a specific national issue. During the first edition the chosen case study was a Vaccination Reminder System and the following year the students worked on the specifications of an Agricultural Market Information System.

The course is characterized by three key ideas: be informal, be interactive, and be practical. Therefore, since the very first moment the students are encouraged to constantly interact with the instructors, who do not deliver frontal lectures, but rather involve the students in interactive explanations. The students are divided in teams and are pushed to have daily “stand up meetings” to update the other students and the instructors about their progress, impediments and next tasks.

The course is based on Agile software development, which is covered at the very beginning of the course. Agile methodologies effectively fit the needs of ICT4D by better dealing with the characterizing issues of such projects and it contributes to the creation of a positive working environment, as seen in [6][7]. In fact, “ceremonies” such as evaluation meetings with Planning Poker [8] stimulate the engagement of all the team members regardless of their individual skills.

#### *4.1 Teaching Methodology*

The key value of the methodology adopted for the SSICT is “learn by doing” and therefore the students are presented with a project to work on since day one. After that, all the teaching activities are performed based on project-related tasks.

Each week's coursework is conducted by a primary instructor and an assisting instructor, supported by the staff of Maputo Living Lab. This serves to guarantee a high level of interaction between instructors and students. All instructors are professors and researchers from Italian and Mozambican universities and institutions who participate to the school on a voluntary basis. The instructors keep a diary that is used for monitoring and sharing information about the progress of the students with the other instructors. The outcomes and findings presented in Section 5 are mostly derived from the diaries of the first two editions of the School.

Regular teaching is interleaved with guest lectures by local domain experts related to the project on which the students are working. These visits are usually very effective to make the students grasp the problem and elaborate a solution that more closely matching the actual needs of the country. During the first edition, the visits by the National Director of the Vaccination Program were particularly useful to improve the students' understanding of the project's requirements. During the second edition, guest lectures included aspects not related to computer science specifically but more on the value of individual creativity. These guest lectures were held by well-known visual artists and their goal was to foster the idea that developing a software project is not only about coding but it involves several other aspects.

#### *4.2 Syllabus*

To cope with the availability of the instructors and the large number of topics to cover, the syllabus is divided equally in 4 parts which naturally fit within the month of the course. Each week is dedicated to a different topic, progressing from the project idea and planning

to the development of the actual prototype. More specifically, the syllabus of the school features the following topics:

- **First Week:** Software Project Management principles. In this week, the students learn the SCRUM methodology [10] and some basics of software design with UML. The week also introduces the project concept, which is improved through brainstorming sessions. The output of this week is a breakdown of requirements (use case diagrams), system-level UML models (class and component diagrams) and a SCRUM product backlog.
- **Second Week:** Java essentials, Database design and introduction to Web Application design. The week covers the fundamentals of object-oriented programming with Java and database design always using the project as case study. Java is adopted as the programming language throughout the course and MySQL is used as DBMS. Web design is introduced by refreshing HTML and CSS concepts. This varies depending on the skills of the students at the beginning of the course. The students work on a database structure for the project and design some of the backend algorithms to work with the data.
- **Third Week:** Web Application design and JSP. This week covers the fundamentals of web application design using Java Server Pages (JSP) and it continues the content of the previous week. The output of this week is a prototype of the backend and web frontend of the case study project.
- **Fourth Week:** Android development basics. During this week the students are introduced to Java development for the Android platform, in particular targeting low-end devices. The output of this week is a prototype of a mobile application capable of connecting to the web server previously developed and of sending and receiving data. The students also work on the development of a mobile interface.

On the first day of the Summer School the students take a self-assessment test meant to understand their knowledge about a variety of computer science topics, including those covered by the Summer School. The content of the subsequent classes is thus adapted to match the students' competences. The instructors constantly adapt the scope of the syllabus above to focus more on the case study and less on a theoretical approach.

## **5 Outcomes**

The SSICT produced different outcomes, most of which were positive. In this section, we summarize our observations from the first two editions and we present the foreseen actions to be carried out as follow-up.

### *5.1 Lessons Learned*

The main takeaway of the SSICT is the effectiveness of learning-by-doing and learning by examples. Although the students seemed to have no exposure to such teaching method, it proved extremely rewarding for them and for the instructors. The students initially found it difficult to adjust to this teaching style but soon started actively participating, providing suggestions, helping with translations when necessary and engaging themselves in problem solving. This allowed to maintain a very informal student-instructor relationship and to continuously exchange feedback.

The use of a real project and the involvement of real stakeholders proved to be extremely effective in making the students own the project and be passionate about it. One of the challenges is to transform a project into a set of learning objectives that ultimately

deliver a working prototype. This could be better achieved by organizing the Summer School as a full-time course, involving more instructors and resources. However, this would require an unlikely full-time commitment from the students who often have a part-time job or who are attending afternoon classes at their University.

Having two instructors at any given time is essential to manage the course and the various contingencies. Identifying one reference person available for the whole duration of the School significantly reduced the workload of instructors and facilitated the relationships with students. During the second edition, such reference person was a Mozambican staff member of Maputo Living Lab who previously participated to the Summer School.

Keeping a diary with the topics covered, the problems encountered and general observations proved to be essential to monitor the school and share information among instructors. Four weekly reports and an initial assessment of the students' skills were produced and condensed in a final report that was shared with the Mozambican Ministry of Education and the Ministry of Science and Technology. This report highlights that the average skills of the students were below the expected average if compared against standard CS curricula. This has been observed with respect to both programming skills, project management and design skills. This was particularly evident when the students faced modeling and other tasks that required some abstraction ability. These results were extremely helpful in refining the syllabus for the second edition and they also suggest that the Summer School itself could be used as a complement for national CS curricula.

The courses were completed not without challenges. Connectivity was an issue in both editions and in general the school had to deal with various infrastructural problems. As a result, the instructors often had to improvise solutions. Similarly, improvisations were needed to adapt the syllabus almost every day as a consequence of the continuous interaction with the students and their uneven competences. To overcome some of these issues, for the second edition MLL invested on renting a laboratory and equipping it with hardware owned by the Living Lab. This considerably eased the problem-solving process in case of infrastructural issues.

## *5.2 Follow-up activities*

One of the goals of the SSICT is to train developers who will possibly collaborate in Maputo Living Lab projects and to further the knowledge transfer between the two partner countries. Two actions have been put in place to achieve this: embedding former students into MLL projects and activating mobility grants from Mozambique to Trento.

In this perspective, a group of students of both editions of the Summer School currently collaborates with Maputo Living Lab in different projects. In particular:

- 12 students from the first edition participated to a project funded by the World Bank (Social Accountability for Mozambique – SAMo [10]) to collect procurement indicators for 50 primary schools in the district of Moamba.
- A mixed group of about 10 students from both editions is currently working on the specifications of a students career web application for Eduardo Mondlane University in Maputo.

Along the same lines, at the end of the second edition of the Summer School, the University of Trento sponsored 5 mobility grants that were awarded to 5 students who participated to the SSICT. The 5 students will be enrolled in 4 master courses at the University and they will be offered an internship at an Italian research organization.

On top of this, all the alumni can access Maputo Living Lab's facilities to develop their own projects and receive support from the local and Italian staff members.

## 6 Future Development

From the experience collected so far, applying and teaching Agile methodologies such as SCRUM is extremely effective for the purposes of the Summer School as well as for the projects. In fact, the students could immediately perceive their progress and plan the subsequent actions to take without having to master excessively formalized methodologies.

For the next editions, we plan to increase the Agility of the projects and of the school itself by revising the syllabus and focusing on a single all-encompassing framework such as Ruby on Rails (RoR). The reason behind this choice comes from the intrinsic support RoR gives to Agile software development and its usage of the DRY (“Don't Repeat Yourself”) paradigm. This will lead to challenges due to RoR not yet being mainstream in Computer Science curricula like Java is and because of the different development model it adopts compared to traditional imperative and object-oriented programming. Despite this, learning such a cutting edge technology will empower the students with highly valuable technical skills combined with Agile project management methodologies that will enable them to become innovators and potential entrepreneurs. Similar initiatives such as Dev Bootcamp<sup>3</sup> have proven that this approach is extremely successful.

Aside from the technological aspects, Maputo Living Lab is set to organize activities to transfer ownership of its software solutions to the students who participated to the related activities of the lab. This will mean organizing specific training periods on the specific projects as it is already planned for SAMo, whose maintainers will soon be the students themselves.

Moreover, the experience can be replicated by organizing a problem-solving Summer School in ICT, including high school outreach through “hackathons.” By incorporating high school outreach, the best and most promising young minds can be encouraged to explore their interest in ICT, ultimately increasing undergraduate enrollment in computer science and information technology. Furthermore, this could facilitate the collaboration with the local government and industries to engage students with real-world problem-solving tasks for economic development and transformation. The summer school methodology has also generated interests and inquiries from other countries (e.g., Ethiopia and Italy), paving the way for possible geographical expansions.

Exploitation and commercialization of the results is another medium/long term challenge we are trying to address. The key points are empowering the students in taking ownership of the solutions (which could be made available open source, to solve issues related to intellectual property), mentoring them in growing their businesses, and try to link with European initiatives, such as the European Institute of Technology<sup>4</sup> (of which both FBK and the University of Trento are part), to provide seed money for the most promising ideas and products.

## 7 Conclusions

The experience so far with the Summer School of ICTs has been perceived as extremely positive and formative both by the students and the instructors, producing several interesting outcomes from the education and innovation points of view.

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<sup>3</sup> <http://devbootcamp.com/>

<sup>4</sup> <http://eit.europa.eu>

We applied an effective learning-by-doing and project-based teaching method that strengthened the competences and technical skills of the students. Our learn-by-doing approach deals with students of diverse backgrounds. The approach provides opportunities for students to display initiative, creativity, presentation skills and constructive criticism. Improvisation is still required to adapt to fill the gaps in the students' knowledge that are hard to identify beforehand. This experience proved also to be an insightful benchmark for the evaluation of the academic level of computer science students.

By putting an emphasis on Agile methodologies and by exploiting the mobile development hype, the Summer School fostered an innovative mindset in the students and stimulated their creativity. This is pushed further by enabling the alumni to use the Maputo Living Lab facilities for free for their innovation projects. The ideal outcome of this is the creation of ICT start-ups that work to tackle national issues.

Finally, the main challenge for the future of the Summer School is that of becoming self-sustained. This will allow to reach and to involve more people by scaling up in other areas of Mozambique and possibly in other countries. We are aiming to draw the interest of sponsors and tighten the collaboration with ICT companies to take advantage of their expertise and resources.



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