Evaluation of the Impact of a Six-year Capacity Building Initiative on Mobile App Development in Senegal

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Abstract

Africa is one of the fastest growing mobile phone markets in the world with more than 630 million mobile subscribers and the lowest mobile penetration rate at 63.9\% (2014). It is experiencing an unprecedented growth in sectors such as health, education, agriculture and citizen participation thanks to mobile technology. Local developers and entrepreneurs with the right set of skills have an important role to play in the creation of mobile services solving local problems. However, very few multi-year capacity building initiatives on mobile app development exist in the region, and universities are often slow in offering new curricula. In this paper, we present and evaluate a model of teaching mobile app development that was implemented in Senegal and used in the last six years through the MobileSenegal project. We determined the impact of this capacity building effort on participants and the Senegalese tech ecosystem by administering a survey in year five, and systematically analyzing the mobile solutions they designed throughout the years. Our findings show that participants are trained with skills that are valuable in the Senegalese job market and MobileSenegal responds to a specific need in the Senegalese tech ecosystem that is not covered by other initiatives. Further directions of MobileSenegal and its sustainability are outlined.

Keywords: Apps; capacity building; education; entrepreneurship; hubs; mobile services.

1. Introduction

Mobile market growth is led by developing nations with more than 5.4 billion subscribers. For comparison, there are 1.5 billion subscribers in the developed world with a mobile penetration rate at 120.8\%. Africa is one of the fastest growing mobile phone markets in the world with more than 630 million mobile subscribers and the lowest mobile penetration rate globally at 63.9\% (ITU, 2014) [1]. It is experiencing a mobile phenomenon orchestrated by local tech and entrepreneurship hubs, operators, startups, international organizations, non-governmental organizations (NGO), and governments. Numerous mobile initiatives have shown an unprecedented impact on users in health, education, agriculture, citizen participation, and business [2]. Illustrative examples include M-Pesa for mobile money and Eneza Education for mobile learning, both focusing on basic phones. M-Pesa was launched in
Kenya in March 2007 as a person-to-person money transfer mechanism and evolved as a consumer-to-business and business-to-business solution subscribed by more than 18 million users [3]. Its success relies on the deployment of numerous agents on the ground and the leverage of basic mobile phones. Also based in Kenya, Eneza Education allows elementary school pupils to get SMS study guides and quiz questions on a phone. In addition, Eneza collects data to evaluate skill levels of pupils in disciplines such as mathematics, Kiswahili, English and Science [4]. Underserved users represent a growing market for operators and entrepreneurs, and have been the target of new mobile services and infrastructures. However, inclusion is still restricted due to affordability, difficulty of use, mobile phone fragmentation, literacy, digital awareness, and local relevance [5].

Mobile entrepreneurs and developers are facing numerous challenges to succeed and scale in Africa. Mobile application production and distribution are controlled by app stores offered by corporations established in the United States, and, thus, not corresponding to the needs of the developing world [6]. App stores are not always offering monetization capabilities in developing counties and registration requires a credit card. SMS services are generally provided by operators who are not yet committed to support or partner with entrepreneurs and reluctant to open their APIs. The most suitable solutions for low-income users involve distributing content directly on devices and SD cards and providing capabilities to purchase and install apps and multimedia at retail outlets [7]. Overall, mobile apps and services from Africa are still limited in number, scope and recognition. Local developers and entrepreneurs with the right set of skills have an important role to play in the creation of mobile services solving local problems. Very few multi-year capacity building initiatives on mobile app development exist in the region, and universities are often slow in offering new curricula and teaching the latest cutting-edge technologies. Parallel to formal education, there are initiatives that focus on exposing African developers to mobile technologies in tech hubs and dedicated coding programs [8]. Very few of these initiatives are multi-year. In Senegal, the country we focus on in this study, from 2011 to 2013, the Web Foundation managed the Voices project in collaboration with Orange and local partners including a university (ESMT) and a tech hub (CTIC Dakar), and trained developers on SMS and voice technology on the emerginov platform during two four-week programs [9]. Google and MIT Global Startup Lab proposed two-week Android training programs in app development in 2010 and 2013 respectively [10,11]. Coders4Africa also offered an eight-week web and mobile training in 2012 [12].

In this paper, we present and evaluate a model of teaching mobile app development that was implemented in Senegal in the MobileSenegal project (http://mobilesenegal.org) and used in the last six years in continuous activities including boot camps, competitions, courses, meetups and faculty training. We examined the impact of this capacity building effort on participants and the Senegalese tech ecosystem by administering a survey in year five and systematically analyzing the type of mobile solutions participants proposed throughout the years. We collected data on participants and the apps they developed from 2009 to 2013. 131 mobile apps were developed in boot camps, competitions and courses by 392 participants. We mapped the mobile ecosystem in Senegal by creating the web site http://mobileecosystem.org on a Ushahidi crowdsourcing visualization [13]. In November 2014, the map identified 90 mobile actors and their target sectors (e.g., education, agriculture, business).

This paper is organized as follows: section 2 describes our model of capacity building; section 3 describes the mobile ecosystem and the work we realized in the last six years as part of MobileSenegal; section 4 highlights our findings; and section 5 concludes and presents our future work.

2. Model for Capacity Building in Mobile App Development

We designed a model of capacity building in mobile app development that takes a holistic approach and favors intensive training sessions. It goes beyond teaching technical skills in mobile app development and covers software engineering, marketing, social media, and entrepreneurship. It emphasizes project-based learning and the importance of soft skills (e.g., pitching, communication and leadership). It relies on the support of a dynamic tech ecosystem. The knowledge acquired is directly applied in the design and implementation of an innovative mobile solution for a client, the sponsor of the software project. Clients can be individuals, companies, NGOs, associations, etc. Mentoring is provided to increase the quality of the mobile solutions / apps and the likelihood of their deployment or their publication in app stores. The model is illustrated in Figure 1.

Technical skills in mobile app development range from programming for a chosen platform (e.g., Nokia, Android, iOS, BlackBerry, Windows Phone) using languages such as Java ME, Android Java, C# and HTML5 to development of SMS services using SMS gateways (e.g., Kannel and FrontlineSMS). Mobile technology evolved
greatly in a short amount of time but it is worth noting that, while our focus moved from Java ME to Android for app development, development on basic phones is still relevant for developing countries where smartphone penetration is low.

Software engineering skills are important in any type of software development. Participants are introduced to software engineering by focusing on Agile Methodologies [14,15,16,17], Human Computer Interaction (HCI) [18,19], testing, and tooling. Agile Methodologies focus on people rather than process, and working software developed in short time iterations (often called sprints) rather than documentation. They are particularly adapted to mobile application development as mobile solutions are activity-centered, have a limited number of features, and require a short time to market. They recommend a close relationship between the client and the development team, a practice that promotes the delivery of software corresponding to business’ and users’ needs. Participants develop their mobile solutions in sprints following the practices of Agile Methodologies. Each platform comes with specific visual, motion and interaction design principles. Google provides designers and developers with comprehensive documentation on the design of Android apps (e.g., color, font, icons, and components’ positioning) to ensure adapted user experience. Each participant has to go through this document and use these principles in their mobile apps. Testing is particularly important for mobile solutions due to device fragmentation. We provide training in testing and app testing. We encourage participants to use external testers and conduct testing on emulators and devices of different types (e.g., phones and tablets), operating systems (OS), sizes and resolutions. Participants use tooling to support the software engineering process. For example, GitHub (http://github.com) is used by participants for code version control (via Git), bug tracking (via the issue system), and project documentation (via wikis).

Mobile app development requires teamwork and different roles: developers, designers, testers, marketers etc. Participants go through the complete software engineering process: requirements, design, implementation, deployment, and maintenance. They also improve their soft skills through interactions and negotiations with clients and regular presentations of their work. Social media and the use of Google AdSense and Facebook ads are presented to market apps. An innovative aspect of the model is that it focuses on having participants work on real projects for real clients and making a direct and observable social impact in their local communities.

We emphasize entrepreneurship through the use of the Business Canvas Model to describe a business model by focusing on revenue streams, channels, customer segments, value propositions, key activities, key partners, and key resources [20]. To ensure commercial quality, participants iteratively improve their prototypes with feedback from the clients but also from mentors who are experts in their domains. They are guided in the creation of startups and encouraged to join tech incubators and co-working spaces to pursue their projects.

Entrepreneurs and industry and NGO practitioners are directly involved in the model. They act as mentors and provide insights on their experience in the field during invited talks. They also offer suggestions for changes in the curricula to better fit the current needs of the mobile market and are employers of our graduates.
3. The MobileSenegal Project

We used the model described in Section 2 during the last six years in Senegal as part of the MobileSenegal project (http://mobilesenegal.org). Founded in 2008, MobileSenegal was the first initiative of mobile capacity building in a Francophone country in Africa, and is currently recognized as a Tech Hub by the World Bank [21]. It was created by Pace University in the US and evolves in collaboration with partners across Senegal and internationally. It started at Thiès and extended to Dakar, St Louis and Ziguinchor. The mission of MobileSenegal is to build capacity in mobile technology by facilitating training activities, organizing events for the wider community, and promoting the work of the mobile community in Senegal. MobileSenegal is a pipeline that trains mobile developers for the Senegalese industry and NGOs and mobile entrepreneurs to be supported further by tech incubators and co-working spaces. It organizes boot camps, courses, competitions and dedicated field projects, and arranges training for faculty. More than 50 faculty were trained in three sessions. To date, more than 350 participants completed boot camps and competitions, and close to 130 applications were developed. Exact numbers for 2009-2013 are provided in section 4. Only 9 apps were released in Nokia Store and Google Play, and 2 apps were piloted in Senegal. MobileSenegal participants were finalists and winners of national and international competitions (e.g., Nokia Calling All Innovators in 2009 and GSMA Mobile Health in 2012). MobileSenegal launched two meetup groups that have a total of 600 members: Mobile Innovations Dakar (http://meetup.com/mobileinnovationsdakar) and Mobile Innovation Thiès (now retired) to share knowledge in a convivial environment. It was instrumental in initiating Mobile Monday Dakar (http://mobilemondaydakar.org) to build a community of professionals around mobile technology. We developed a good understanding of the Senegalese mobile ecosystem to rely on. We identified mobile actors on a Ushahidi crowdsourcing map available at: http://mobileecosystem.org. The map includes the telecommunications regulator, operators, companies, NGOs, startups, incubators, co-working spaces etc. Figure 2 presents more than 90 actors of the Senegalese mobile ecosystem. Table 1 provides information about the participants and activities of MobileSenegal.

Figure 2. Senegalese Mobile Ecosystem. Screen capture from http://mobileecosystem.org. (Last update: November 2014)
<table>
<thead>
<tr>
<th>Year</th>
<th>Boot camps, competitions courses</th>
<th>Themes</th>
<th>Apps</th>
<th>Male participants</th>
<th>Female participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>1, 1, 0</td>
<td>Artisans; Elementary education</td>
<td>16</td>
<td>43</td>
<td>4</td>
</tr>
<tr>
<td>2010</td>
<td>3, 1, 2</td>
<td>Social development; Students’ life; Mobile Solutions, Local Cultures and Languages; Empowering Women and Girls</td>
<td>40</td>
<td>90</td>
<td>37</td>
</tr>
<tr>
<td>2011</td>
<td>1, 1, 1</td>
<td>Smarter Cities</td>
<td>29</td>
<td>61</td>
<td>10</td>
</tr>
<tr>
<td>2012</td>
<td>1, 0, 0</td>
<td>Social change</td>
<td>5</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>2013</td>
<td>0, 1, 2</td>
<td>Mobile web apps &amp; SMS on health; Apps for Senegal</td>
<td>41</td>
<td>105</td>
<td>22</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,4,5</strong></td>
<td><strong>131</strong></td>
<td><strong>315</strong></td>
<td><strong>77</strong></td>
<td></td>
</tr>
</tbody>
</table>

4. Methodology and Findings

**Methodology.** We administered a survey to all the participants of MobileSenegal’s activities (more than 600 participants) in year five. The survey covered the motivation of the participants, the skills they acquired, the impact of the initiative on their career, and the weaknesses and strengths of MobileSenegal. We also analyzed and categorized the apps participants developed between 2009 and 2013.

**Survey Results.** The survey was answered by 163 participants (14.4% of females). Only 45 participants completed the survey entirely. Participants were very satisfied with the activities of MobileSenegal and considered it as a pioneer in mobile in Senegal (87.7%). Participants would recommend its activities to friends (100%). They were particularly interested in mobile development for the Android and Windows Phone platforms (81.7% versus 7.7%). They cited interest in technology (19.9%), getting skills in mobile app development (17.7%) and networking (14.4%) as the main reasons to participate in MobileSenegal activities. Participants felt that the skills they acquired helped them strengthen their CV (25%) and get an internship (16.4%), ignited their interest in mobile and entrepreneurship (22.4%), and supported their day-to-day job (8.6%). They gained skills in mobile development (Java ME, HTML5 and SMS technology), software engineering, design, testing, Agile Methodologies, English, team-work, and collaborative tools (e.g., GitHub). Their skills permitted them to secure internships and employment in the most recognized startups and companies working in mobile in Senegal. Graduates from boot camps are currently working at: WARI, Money Express and Ferlo, mobile money providers; ARTP, the telecommunications regulator; Manobi, one of the first startups proposing mobile solutions; Orange and Tigo mobile operators; People Input, the most recognized web and digital agency in Senegal. Participants particularly valued networking with practitioners and meeting with other community members (e.g., CTIC Dakar and Jokkolabs) through MobileSenegal. MobileSenegal is perceived as very important (40.8%) and important (53%) in the Senegalese tech ecosystem due to the role of mobile technology in Africa, its focus on mobile for development (M4D), and the
importance it gives to training faculty. Few apps were published in app stores and piloted in Senegal. Participants mentioned that time deficiency, impossibility of registering for a developer account without a credit card, and lack of mentoring as main reasons. Publishing an app was not one of their priorities.

Analysis and Categorization of the Apps. 131 mobile apps were developed by 392 participants in boot camps, courses and competitions between 2009 and 2013. The number of male participants was larger than the number of female participants (296 versus 71). The main population was composed of students. Only 9 apps were released in Nokia Store and Google Play and 2 apps were piloted in Senegal. An app for artisans to manage their expenses and sales (KomKom) was piloted during two months at the Artisan Village of Thies, and an app for children to learn numbers (WanniGame) was used by pupils in a school in Thies. Participants were particularly interested in developing solutions targeting the needs of local users. Apps proposed by participants mainly focused on Health (37), School Administration (23) and Education (16) (See Table 2). Most of the health apps were health education apps with content on maternal health, blood donation, vaccine, malaria and diabetes, apps that improve communication between doctors and patients, and information on health facilities. School administration apps reflected on the everyday life of Senegalese students and some of their important and urgent concerns. They targeted academics (e.g. accessing schedule changes and exam grades), campus dining (e.g., getting restaurants’ menu and queue status), campus housing (e.g., dorm room reservation and repair) and orientation (e.g., map of the campus) [22,23]. Education apps focused on quizzes and study guides for children to learn numbers and letters, and apps to learn about Africa, the environment and Wolof.

<table>
<thead>
<tr>
<th>Category</th>
<th>Apps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business</td>
<td>7</td>
</tr>
<tr>
<td>Civism</td>
<td>4</td>
</tr>
<tr>
<td>Consumer</td>
<td>1</td>
</tr>
<tr>
<td>Cooking</td>
<td>4</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td><strong>16</strong></td>
</tr>
<tr>
<td>Entertainment</td>
<td>2</td>
</tr>
<tr>
<td>Finance</td>
<td>15</td>
</tr>
<tr>
<td>Game</td>
<td>1</td>
</tr>
<tr>
<td><strong>Health</strong></td>
<td><strong>37</strong></td>
</tr>
<tr>
<td>Productivity</td>
<td>7</td>
</tr>
<tr>
<td><strong>School Administration</strong></td>
<td><strong>23</strong></td>
</tr>
<tr>
<td>Tourism</td>
<td>3</td>
</tr>
<tr>
<td>Transportation</td>
<td>8</td>
</tr>
<tr>
<td>Weather</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>131</strong></td>
</tr>
</tbody>
</table>

5. Conclusion and Further Work

In this paper we described our model of teaching mobile app development that relies on a holistic approach that focuses on technical skills augmented by software engineering, marketing, social media and entrepreneurship skills. Our offering focuses on training developers and entrepreneurs for the industry needs, and aligns with the requirements and needs of users in developing countries. The crucial components of the model are the organization of intensive boot camps for selected students and competitions to reach out to more participants and the tech community in Senegal. Another important aspect is the involvement of the tech ecosystem and universities. While
tech hubs may offer sporadic mobile app development training, these initiatives are not sustained. We see our initiative as a pipeline to provide technically skilled mobile app developers with basic skills in entrepreneurship who will be the best candidates for tech hub incubation. MobileSenegal was the first initiative on mobile training in Senegal and educated a large number of professionals who are now active in the tech community in Senegal.

We are currently looking at new models to sustain our initiative through intensive training of instructors, and new models of teaching to accelerate the release of enterprise and consumer mobile applications and train more participants at once. We plan to extend our activities in Africa (e.g., Benin, Burkina Faso and Tanzania). We will base our new model on offerings such as coding schools (e.g., General Assembly and Flatiron School in the US) and online teaching.

Acknowledgement

We thank all the participants of the MobileSenegal activities for their involvement and feedback. We are particularly grateful to Amdane Samb, Landry Ahouansou, and Mame Ibrahima Bakhoum for their work with MobileSenegal. We also thank our sponsors since 2009: VentureWell (ex-NCIIA), Google, IBM, WARC (West African Research Center), Neurotech, and Djanoa.

References