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MOBILE APPLICATIONS IN UNIVERSITY EDUCATION: THE CASE OF KENYA

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The widespread adoption of mobile phones has brought an increasing interest in the development of mobile applications for higher education. In this paper we examine the use of mobile applications in university education, focusing on Kenya, a leading country in mobile services. The main goal is to investigate if university students are using or would like to use mobile phones and apps, in particular educational apps. Information gathered from the study gives an insight on which apps to adopt or implement in university education.

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1 Introduction

The mobile phone is a ubiquitous device that many cannot imagine living without. This device is a widespread form of personal technology that is used for making and receiving phone calls, sending and receiving text messages, video and audio capture, and basic editing. In addition, it is used as a personal organizer, and for accessing mobile applications (apps) that provide a myriad of services in healthcare, education, agriculture, finance, hospitality, governance and environmental services among others. In the education sector, mobile applications have been identified as one of the six technologies to be watched for higher education advancement (Horizon, 2012). More importantly for our study, 90% of online time is spent using mobile apps (Smartinsights, 2016).

In this paper we will investigate the use of mobile apps in university education, focusing on Kenya, a leading country in mobile adoption and services (Murray, 2015), as confirmed by data on mobile penetration and mobile apps development (CAK, 2016). The main goal is to investigate if university students are using or would like to use mobile phone apps, in particular educational apps. Information gathered from the study will give insight on which apps could be adopted or implemented in university education. An analysis of some innovative technologies which when used with mobile apps could leverage their impact is also proposed.

According to the Global Digital report, almost two-thirds of the world's population currently has a mobile phone, and more than half of this uses smartphones; in addition, over half of the world's web traffic currently comes from mobile phones (Wearesocial, 2017).

In Africa, while Internet user penetration is only 29% (compared to the 50% of the world average), mobile phone penetration reached 71% in January 2017. In Kenya, Internet users penetration was 78% in March 2017 (compared to 45% in 2016 and 7.5% in 2006); mobile user penetration was 88.1% in 2015 and reached 90% in 2017 (CAK, 2016).

As for the apps market, worldwide downloads grew by 15% from 2015 to 2016, and the time spent using apps grew by 25%. Google Play and the iOS App Store with 2,800,000 and 2,200,000 apps respectively in March 2017 lead the mobile apps market (App Annie, 2016). Available data shows that the most popular App store categories by share of apps market are games (25.04%), business (9.88%) and education (8.36%).

Focusing on Africa, 2.4 million direct jobs were created in Sub Saharan Africa by the mobile ecosystem in 2013, and this is expected to rise to 3.5 million by 2020 (GSMA, 2014). Furthermore, the mobile ecosystem has deepened democracy through citizen participation (HellStrom, 2010), enhanced social ties due to more frequent use (Shrum *et al*., 2011) and improved livelihoods,

among others.

Nicknamed the Silicon Savannah, Kenya is a re-known hub for innovative mobile applications in Africa. Applications incubated and popularly used in Kenya include, MPESA, a money transfer system that uses SMS to facilitate payment of bills, sending and receiving cash, banking and purchasing of products; Ushahidi, a crowd-sourcing app for sharing crisis information; M-Farm, that informs farmers about current market prices, agricultural trends and offers them the ability to collaborate; MedAfrica that helps diagnose symptoms, offers prescriptions, authenticates counterfeit drugs and directs patients to the nearest hospital if all interventions fail[1].

Focusing on the education sector, this paper presents the results of a survey carried out across three Kenyan universities in 2015. The main objective of the study was to identify the mobile apps used for educational purposes by students in Kenyan universities, and to investigate the apps and services considered useful by students. From the perspective of universities and mobile application developers, the goal of this paper is to provide insights about the potential demand of educational mobile apps for use in Kenyan universities, and in turn other universities across Africa.

The rest of the paper is organized as follows. Section 2 introduces some classifications for mobile apps in education. The survey and the main results are presented in the third section. Section 4 introduces some of the most innovative technologies which when used with apps could leverage their impact. Finally, the last section gives the conclusion, and future work.

2 Uses of mobile phones in university education

In university education, the ubiquitous mobile phones present a huge potential because of the large number of activities and tasks they can support (Valk *et al*., 2010). The USA ranks first in the field of mobile learning probably due to the fact that it is one of the best states in the world in terms of technology (Soykan & Uzunboylu, 2015). In Japan, m-learning already has a rich and vibrant history and in 2005, practically 100 percent of college students and working adults in Japan owned a mobile phone (Kato & Ricci, 2006). However, a systematic review by Alioon and Delialioglu (2015) revealed that m-learning projects have been considered more in developing countries than developed ones as they are cost effective. Besides, many m-learning projects have been applied dominantly for K12 environments rather than higher education and the most frequently used approaches for implementing m-learning are mobile applications, followed by SMS and mobile game projects respectively, whereas smartphones are the most common devices in terms of m-learning. The down-

[1] www.safaricom.co.ke; www.ushahidi.com; www.mfarm.co.ke; www.medafrica.org

sides to mobile learning that may impede its adoption include: actual feasibility depends on the interest and diligence of learners (Kukulska-Hulme, 2005); wireless technology may require universities to impart successful degrees to the same caliber of students, if mobile learning is to be included as a mainstream education platform (Ally, 2009); security issues and designing a common user interface itself is a challenge (Alrasheedi & Capretz, 2015). In Switzerland, data collected from 2 universities in Ticino showed that only 17.3% of students consider mobiles important tools for learning, and while 42% of students use mobile phones for learning, 3 out of 4 use them to interact with their peers (Rapetti *et al*., 2011). Many instructors believe that students use mobile phones for socializing purposes when they reported that they were doing study-related tasks (Pollara, 2011). As much as many learners are receptive of m-learning, instructors are skeptical of the idea and are slow to adopt it (Alrasheedi & Capretz, 2015). Focusing on Africa, a high percentage (over 90%) of university students in Nigeria's Kwara State have a positive attitude towards mobile learning with many concurring that if adapted it would enhance learning and over 85% being ready to adopt it if introduced (Adegbija & Bola, 2015).

Few researchers have attempted to categorize mobile apps use in education. Laurillard (2002) developed a conversational framework for the effective use of learning technologies, which can be applied in a range of subjects. Kole (2009) developed FRAME (Framework for the Rational Analysis of Mobile Education) which classified mobile learning according to three characteristics, namely: the device, the learner and the social environment, thereby highlighting the social, personal and technical aspects which can help determine the effectiveness of mobile learning. FRAME is a comprehensive model that is useful in planning and designing mobile learning environments because it suggests a checklist of questions that can guide the development process. The framework by Park (2011) has four types of mobile learning which are: *high transactional distance socialized m-learning* where learners are involved in group learning and have more communication space with their instructor; *high transactional distance individualized m-learning* in which individual learners receive tightly structured content and control their learning process to master it; *low transactional distance socialized m-learning* where learners have less psychological and communication space with the instructor as well as loosely structured instruction and work together in a group and *low transactional distance individualized m-learning* in which there is less psychological space between instructor and learner, is loosely structured and the instructor leads the learning. Patten *et al*. (2006) developed a functional framework for categorizing handheld educational applications that views the mobile learning design space in terms of application functions and pedagogical underpinning (Figure 1).

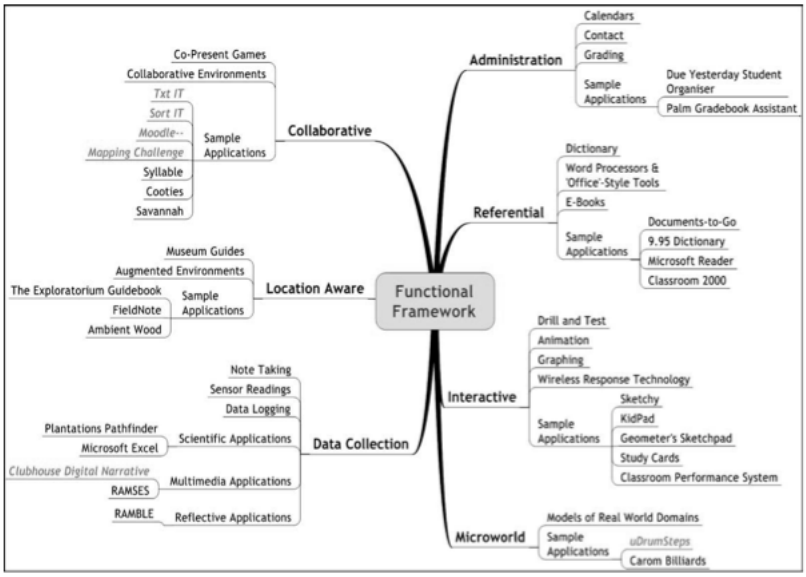

Fig. 1 - Functional framework (Patten *et al.*, 2006)

The seven categories in the model are: *administrative apps* which focus on informative storage and retrieval while replicating available tools on traditional platforms; *referential apps* that allow accessing of content at learning places; *collaborative apps* that encourage knowledge sharing in the learner's physical context and enhance collaborative learning principles; *location aware apps* which contextualize learning activities by facilitating appropriate interaction among learners and their environment; *data collection apps* used to record reflective, scientific and multimedia data about the environment; *interactive apps* that focus on content delivery and information management via a 'response and feedback' approach; and *microworlds* that allow learners to construct their own knowledge through experimentation in constrained models of real world domains. These categories have been used to identify and classify apps for universities (Table 1), and then to extract those to include in the questionnaire used for the survey.

Table 1
CLASSIFICATION OF APPS BASED ON THE FUNCTIONAL FRAMEWORK

Class of applications	Examples of mobile app functions
1.Administrative apps	Attending classes (virtual classroom) Authentication when entering the campus Booking rooms of residence Course registration Delivery of lectures and other course materials Fees payment Making notes during class Monitoring student progress Mind-mapping (for mapping out ideas) Preparation of lecture notes Provision of help desk information Recording of class attendance Relaying of campus news and events Time tabling Uploading of assignments Uploading and dissemination of exam results Voting and polling processes
2.Referential apps	Dictionary eReaders Language translators Mobile tactile braille Provision of access to research databases Reminders Searching library catalogues Sign language interpreter Sign language learner Text-to-speech app
3.Interactive apps	Answering questions in class Creating flash cards Educational games Lab experiments simulators Unit (subject) focused apps Unit (subject) examination/quiz
4.Microworld	Creating apps in computing courses Creating podcasts Creating videos Making presentations
5.Data collection	Analysis of data collected during research Data collection
6.Location aware	Provision of self-guided campus tours Virtual maps
7.Collaborative	Collaborative writing Facilitation of discussions among classmates Facilitation of interactivity between students and lecturers Inviting guest lecturers

3 The study

The goal of the study was to investigate the potential demand of mobile apps within Kenyan universities. It was conducted at the University of Nairobi, The Co-operative University College of Kenya and Great Lakes University of Kenya. These universities were chosen because they are representative of the higher education institutions landscape in Kenya, which include established public universities, university colleges and private universities. The study was based on a structured questionnaire that was completed online and on hard copy. Trained research assistants interviewed students at the three universities randomly selected from their class lists, and entered the responses on the paper-based questionnaires. The population consisted of both undergraduate and postgraduate students.

An on-line version of the questionnaire was offered to students who were unable to meet with the researchers. In this way it was also possible to gather informal comments and remarks. The questionnaire had 16 questions. The goal of the first 5 questions was to investigate the ownership and use of mobile phones. Questions 6 to 14 examined different topics related to the apps; apps installed on the mobile phone (number and kinds); types of mobile apps used for academic purposes and their impact on learning processes and results; mobile apps hosted by the university if any; usefulness of a set of relevant mobile apps a university could offer to its students and suggestions for any other apps that could be offered by the university. The last two questions sought to know the respondents' university and the age range. The survey was run in autumn 2015 and sampled a total of 134 respondents; over 99% were aged 35 and below. A pre-test of the questionnaire was carried out at The Co-operative University College of Kenya's faculty of commerce.

3.1 Results

The first result of the study confirmed that a huge percentage of students (95.6%) who participated in the survey owned a mobile phone, a percentage higher than the 82% of all the population in Kenya (Wearesocial, 2017). 89.6% of the respondents owned a smartphone, compared to the 44% for all the population (Google Barometer, 2016). In the case of Kenyan students, the percentage is also higher than that measured in the US, 86% (Pearson, 2015). This is possibly due to the affordability of mobile phones in Kenya that cost approximately 10 $ for the cheapest feature phone and 50 $ for the cheapest smart phone. Only 35.2% of the respondents had owned the mobile phone for more than 2 years (41% for less than 1 year), showing that most of the students are in possession of new generation mobile phones.

Answers to the question on how long they can do without a mobile phone exposed that 77.7% of the respondents could not spend more than one day without accessing their mobile phones: 39.6% could stay without their mobile phone for less than 1 hour, while 26.5% for between 1 to 5 hours maximum. For most of the students using a mobile phone had become a habit and they felt the need to stay connected at all times (41.8%). The findings are consistent with those available in (Wearesocial, 2017; Pearson, 2015). With regard to the frequency of mobile phone usage, most students (83.5%) used their mobile phones between 1 to 10 times a day.

Another question investigated the type of default applications installed on respondents' mobile phones. The findings show that the majority of students had installed messaging (text) apps (83.6%), calculators (76.9%), browsers (76.1%), alarms (74.6%), recorders (70.1%), banking/shopping apps (69.4%), a percentage higher than in most of the other countries (Statista, 2014), convertor (60.4%), organizers (56.0%) and weather forecasting apps (44.0%). As for the number of non-default apps installed in the students' mobile phones, the majority of them (78.4%) had installed between 2 to 15 non–default apps. Of these, it was reported that games (69.4%), and social networking apps (61.9%) were the most popular; e-reader and instant messaging are used by 35.1% of the students; followed by news (29.9%) and video streaming (29.1%) which depict that the students mainly use their mobile phones for communication and entertainment. Gambling apps are at 14.9%; travel, television and e-ticketing stood at about 10%. Focusing on educational apps, only 3.7% of the students did not use any. Among the most popular academic uses of mobile applications were: accessing a dictionary (63.4%), accessing course materials (61.9%), and registering for courses (61.2%); about half of the students use apps to download research publications (53.7%), to download assignments (51.5%); a smaller percentage used it for undertaking quizzes or exams (20.1%) and playing educational games (15.7%) (Table 2).

Table 2
ACADEMIC PURPOSES OF USING MOBILE PHONE APPLICATIONS

Purpose	Number	%
Use the dictionary	85	63.4
Access course materials	83	61.9
Register for courses	82	61.2
Download research publications	72	53.7
Download assignments	69	51.5
Take lecture notes	48	35.8
Hold class discussions	41	30.6

Purpose	Number	%
Reserve library resources	28	20.9
Use language translators	28	20.9
Undertake quizzes/examinations	27	20.1
Play educational games	21	15.7
Do not use for academic purpose	5	3.7
Others	2	1.5

Respondents were then asked to indicate the type of the educational functions they would have on mobile phone. A majority of students gave the following rankings: 56.7% of the students desire apps for receiving/submitting assignments, and for class timetables; 53% desire to receive notifications of exams grades. More than one third of them desire to receive campus news and to access the campus e-library (Figure 2).

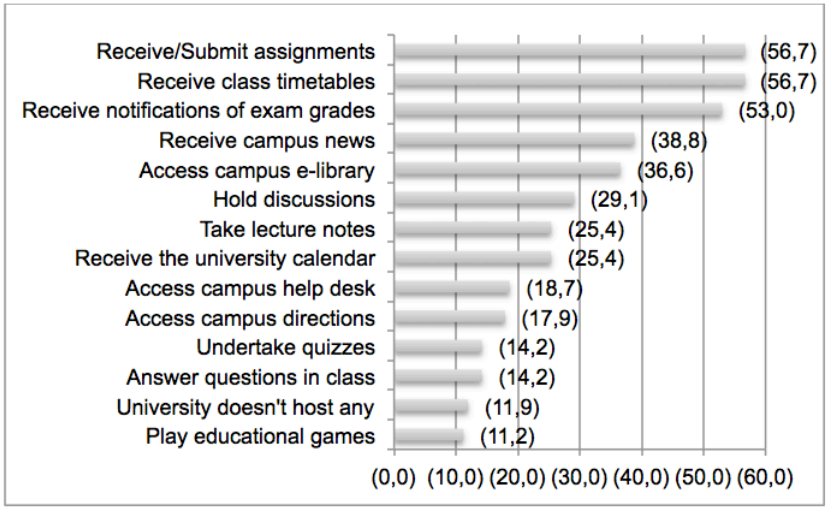

Fig. 2 - Educational mobile application functions desired by students (%)

Data regarding the usefulness of educational mobile apps showed that for students the most useful apps are those for receiving quiz and exam results (82.1%), accessing campus e-library (80.6%), receiving and submitting assignments (76/1%), and holding discussions (73.1%) (Table 3).

Table 3
PERCEIVED USEFULNESS OF MOBILE APPLICATIONS (%)

Apps	Not useful	Neutral	Useful	Missing
Accessing campus e-library	10.4	5.2	80.6	3.7
Attending virtual classes	21.6	14.9	59.0	4.5
Creating videos and podcasts	25.4	16.4	52.2	6.0
Holding discussions	14.2	8.2	73.1	4.5
Mapping out ideas	13.4	11.9	64.2	10.4
Playing educational games	25.4	24.6	44.0	6.0
Receiving and submitting assignments	9.7	6.7	76.1	7.5
Receiving quiz and exam results	5.2	8.2	82.1	4.5
Taking lecture notes	14.2	12.7	69.4	3.7
Undertaking quizzes and exams	18.7	11.9	64.2	5.2

3.2 Discussion

Students sampled in the study were found to spend an ample amount of time engaged in them. Most of the students had default apps, as messaging and social networking apps, installed on their phones, which is consistent with findings from previous studies by (Zulkefly & Baharudin, 2009; Lie, 2004; Maddel; Muncer, 2004; and more recent data reported by Google and Wearesocial). This is probably because the cost of communication via SMS and social networking tools is lower than voice calls, and students have limited financial resources.

As regard educational apps, many students desire to have apps that would help them submit and receive assignments as well as timetables and campus news. This is consistent with the trend in which people want easy and timely access to not only the information on the network, but also to tools, resources, and up-to-the-moment analysis and commentary (Horizon, 2012).

Most of the students perceive mobile apps for holding discussions to be useful also in an educational context. This is probably because they are already accustomed to apps for social networking communication, where they can easily set up groups and carry on with discussions. This trend could also be a result of the increased uptake of social media as evidenced by the rise of mobile social media use in Africa by nearly 50% during the year 2016 (Wearesocial, 2017).

Findings from the study highlight that a high number of students would like to access e-library services online, whereas below half of the ones sampled do have such service. The interest in accessing e-library services is possibly due to the rise in internet and data subscriptions (CAK, 2016) as well as the wide range of information that students could exploit when carrying out assignments and research.

Other results to be highlighted are those related to educational games: many

students did not play and did not desire to have any educational games apps. This finding is contrary to the postulation by Brigham (2015) that many people are attracted to gamification as it enhances participation and engagement. A reason for this contradiction could be that this concept has not been applied across local institutions in Kenya and thus educational game apps cannot be perceived as useful by students.

4 Technologies for leveraging educational apps

Novel technologies are blurring the line between education and leisure and can be used with mobile phones in education to develop new and innovative mobile apps. For example, all the universities surveyed offer e-learning, though the mode of delivery is rudimentary since the course content is offered mainly through PDFs. The universities need to make their e-learning systems more interactive through educational apps. Technologies that can be applied with apps to address that challenge and to support functions desired and considered useful by students (Figure 2 and Table 3) include: augmented reality (AR), Internet of Things (IoT), mobile learning analytics and game based learning.

Augmented Reality by inserting virtual information into the real world through apps allows enhancement of a user's perception to learn about and annotate his environment (FitzGerald *et al*., 2013), promoting engagement and motivation (Klopfer & Squire, 2008; Luckin & Stanton Fraser, 2011; Kesim & Ozarslan, 2012).

In the IoT, the Internet connecting physical things, mobile apps can be used as control devices or actuators (Want *et al*., 2015) and let the students take an active part in many activities (Bandyopadhyay & Sen, 2011). For example, IoT apps have been applied to learn about cultural attractions (Chianese & Piccialli, 2014), to record students' class attendance automatically, to access smart packing spaces (Nie, 2013), to locate places within campus and to personalize students' apartments.

Mobile learning analytics refers to the collection, analysis and reporting of the data of mobile learners, which can be collected from the mobile interactions between learners, mobile devices and available learning material (Aljohani & Davis, 2012). The purpose is to observe and understand learning behavior to enable appropriate intervention (Educause, 2011). The final feedback gives not only the overview of correct solutions, but also a detailed analysis of typical errors (Ebner *et al*., 2014).

Game based learning, or Gamification uses game features - elements, mechanics, frameworks, aesthetics, thinking, metaphors - into non-game settings and support more interactivity while learning (Faiella & Ricciardi, 2015; Notari, *et al*. 2016; Prensky & Prensky, 2007). The *Serious Games* movement has

focused on uniting significant educational content with play (Horizon, 2012). Examples of gamified mobile apps to enhance learning are Duolingo, a free language-learning app where users are provided instant feedback and gain 'experience points' (Brigham, 2015); SCVNGR is a location-based mobile gamification app with customizable treks and challenges, so that students can discover more about the school and the campus in the form of a scavenger hunt (Keller, 2011); Fantasy Geopolitics motivates students to learn more about their countries by news reading (Magdaleno, 2014). Library Quest engages users by asking them to input alphanumeric codes or to scan QR codes displayed in the library building to encourage them to explore the library building and to make them aware of various library services (Felker, 2013).

Conclusions

For any university that is innovative and continuously exploring new strategies for education, ignoring the potential of mobile apps is generally detrimental to progress, and it would imply refusal to adapt in a continuously changing world. The study based in Kenya, throws some light on the apps a University could offer to its students. Almost all of them have a focused scope and are meant for daily use. These results are possibly useful for educational apps anywhere in the world. According to the results of the survey, there is a large potential arising for educational institutions to exploit mobile apps in enhancing learning; but also administration and other activities could benefit from students behaviors and needs in relation to mobile technologies and apps. For example, across the Kenyan Universities, students currently utilize commercial applications such as MPesa, useful also for the administration for purchasing and payments (in tandem with the high volume of mobile commerce transactions on a rising trend in Kenya (CAK, 2016)).

From the possible adoptions and uses of mobile apps in education, it is notable that most of the initiatives are prevalent in the developed world (http://www.unesco.org) possibly due to sustainability issues (Traxler & Leach 2006), while data on mobile and apps usage show high percentages in African countries; highlighting a huge potential for demand and use. Education institutions and universities especially in the developing world should consider incorporating mobile apps in learning as this would optimize the ways in which students learn by opening up new education doors and improving efficiency in carrying out of administrative duties. It is also important to note that if mobile apps usage in universities lack directed learning activities, they may be detrimental to the overall learning process and this study offers preliminary insights on the kind of apps that could be adopted and developed to support university processes.

As for the technologies illustrated in section 4 that could enhance the per-

formances and the scope of apps, Kenyan universities are lagging behind in comparison to their competitors in the developed nations. Of the three universities surveyed, only the University of Nairobi has a laboratory that offers training on IoT in which startups work on a range of IoT projects. This situation is probably due to the lack of funds limiting the investment of the universities in the latest technologies. Kenyan universities could then collaborate more with world re-known universities and be more innovative in generating funds to support the integration of these technologies. Future work include an analysis of their adoption to implement innovative educational apps addressing the needs highlighted by students. Another area that needed to be investigated is that of mobile apps and MOOCS (Massively Open Online Courses). None of the universities in the survey offers or has adapted online courses offered through MOOCs such as Udemy, edX or Coursera. Through MOOCs there lies a great potential which if exploited would imply a better global presence of Kenyan universities, as their courses would be available worldwide, faculty could have a wider audience for selling course materials, and the institutions could make savings on staffing needs, among other benefits.

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