Information Communication Technology Penetration and its Impact on Education: Lessons of Experience from Selected African Countries of Ghana, Kenya and Rwanda

Samuel Yaw Ampofo[1], Benjamin Bizimana[2], John Mbuthi [3], Irénée Ndayambaje [4], Norbert Ogeta[5] and John Aluko Orodho[6]

Ghana[1], Rwanda[2,4], Kenya[3,5 &6], Department of Educational Management, Policy and Curriculum Studies, School of Education, Kenyatta University, Kenya

Abstract

The study examined the extent of penetration of Computer and Internet as Information Communication Technology (ICT) tools and their potential positive impact   on educational institutions, individuals and societies at large. The study employed a mixed methods approach involving quantitative and qualitative approaches using secondary and primary data sources. The study was premised on the social cultural theory propounded by Vygotsky in the early 20th century which emphasizes the role of the society and interaction in learning and development process. This study focused on lessons of experience regarding the extent ICT has transformed education in Ghana, Kenya and Rwanda. The study largely relied on secondary data available mainly in official websites, published documents like articles in journals and unpublished documents as well as primary data from interviews with leading educationists, researchers and policy makers in the Eastern African Region. The findings in the three countries show the existence of political awareness and will to make ICT a transformative and economic tool. Practically on the ground, educational institutions and their stakeholders have already embraced ICT and their actions are portrayed in the progressive efforts to avail required basic ICT infrastructure and future roadmaps of the targets to hit. It was also noted that Rwanda is taking the lead in the achievements in ICT. It was also evident that the three countries were experiencing nearly identical challenges ranging from inadequate funding to put in place appropriate tools and infrastructure   and low level of ownership and sustainability of ICT projects. The study recommended the punctual monitoring and evaluation of ICT projects; follow up and enforcement of policies and resolutions, synergize all educational stakeholders' efforts and expertise together as some of the coping strategies with the highlighted barriers. Invariably,   countries should learn from one another in terms of achievement made and challenges to be overcome.[[293 words]

Key words: *Information Communication Technology (ICT), ICT penetration, ICT in education, ICT impact, Ghana, Kenya, Rwanda*

Introduction

Background to the Study

 There is rapidly growing body of literature from educationists, researcher and policy makers from developed and developing countries regarding the unequivocal significance and role of Information Communication Technology (ICT)   as one of the prime tools that have the potential to modernize societies, boost economy and bridge huge barriers such as distance, equity and time associated with the traditional World (Chitiyo & Herman,2009; Debande& Otterson,2004; Namney,2012; Ndambayaje & Orodho,2014). In reality, the adoption and use of ICT in education is not just an imitation or unwise copy paste of what other sectors do. It has basis in the evidenced fact that ICT challenges and develops the traditional learning environment through the introduction of new educational tools and facilities such as e-learning (Debande & Ottersten, 2004). Moreover, ICT in education emerged as an imperative for education to respond to the increasing pressure from the labour market to produce competent, skillful and adequate manpower apt to cope with the dynamic, competitive and highly demanding contexts and societies at large (Debande & Ottersten, 2004; Ndambayaje & Orodho,2014).

The speed at which ICT is making an impact going by the diffusion and penetration of Personal Computers (PC) both in the European Union (EU) and in the United States of America (USA) is quite fast and has attained high rates in schools, workplaces and homes, which contributed to the economic growth and facilitated the adoption of innovations. What is more, in school settings, 76% of the EU schools have computer laboratories, 50% have classes equipped with computers, a high percentage of students and teachers have laptops (Debande & Ottersten, 2004). The authors go on saying that The Internet connection is available in all schools and what differs is the type of connectivity (ISDN, standard dial-up or broadband) which depends on the type/level of the school, country/location and the programmes on offer.

Various studies have testified the positive impact of ICT in the academic milieu. For instance, a study conducted in Estonia by Uibu & Kikas (2008) has averred that the introduction of ICT has altered the teachers' perceptions about the roles in education, increased the motivation to learn, facilitated the educational tasks, facilitated more collaboration and brought about the possibility to vary the methods of teaching. Rightly turning to ICT impact in

India, Namdev (2012) established that the traditional physical academic learning environments are shifting to distance and online due to the increasing use of Internet and web tools.

Currently, ICT has penetrated Africa and forced educational institutions to purchase, install and use them. In Zimbabwe, Computers were donated to communities in rural schools Mpofu et al., (2013) and university lecturers were using ICT in pre-service secondary school teacher education programmes (Chitiyo & Harmon, 2009). According to studies conducted by Mukama and Andersson (2008) as well as Ndayambaje and Orodho (2014), the impact of ICT on this continent, especially in Rwanda has been well documented above and beyond computer availability in primary, secondary and higher education. In the same vein, a study carried out by Ndayambaje & Ngendahayo (in press) shows that ICT not only increases teachers' competence but also constitute an unimaginable tool towards teachers' Continuous Professional Development (CPD). It is against this backdrop that this study got the impetus to examine the role of Information Communication Technology Penetration and its Impact on Education by drawing lessons of experience from Selected African Countries of Ghana, Kenya and Rwanda

Literature review

ICT tools, uses and development

The concept of ICT-Information Communication Technology- refers to a big set of tools and applications aimed at capturing, storing, displaying and sharing data and information in electronic way (Debande & Ottersten, 2004). In education, ICT is playing a lot of roles ranging from mediating the teacher, the learner and the content to facilitating more interactions in a modernized and flexible way. It is arguable that, ICT has brought about substantive changes. Invariably, while teaching and learning mandatorily required the physical presence of the teacher and the learner in a fixed place, current extensive use of ICT has challenged the educational institutions, knowledge seekers and providers by making possible unlimited and open access to education (Namdev, 2012; Ndambayaje & Orodho,2014). Some of the new educational facilities are multimedia resources, e-library, e-learning, distance learning, life-long-learning and social networking services(Ndambayaje & Orodho,2014).

ICT as any other enterprise endeavor passes through three complementary stages of development for its successful implementation. These are Connectivity, Integration, and Deployment (Debande & Ottersten, 2004). The main ICT inputs are reflected in terms of infrastructure, hardware, software and support services while its effective embracement are determined by basic skills literacy, attitude, flexibility and community ownership (Debande & Ottersten, 2004).

The development in the use of ICT goes with time, hence more ICT tools and applications are expected in the future. It is on the basis of this fact that Christie et al (2002) report that while in 1990's teachers used personal computers (PC) in education to prepare or store lecture notes, these PCs are now multipurpose and are assisting not only teachers but also students and further educational partners to handle a good number of educational duties.

Impact of ICT on educational achievement

The ICT adoption in education has been motivated by its evidenced positive impact on the education provision, quality and support. In line with this, Christie et al. (2002) firmly contend that ICT is at the heart of life-long-learning, learner-centered education, off-campus course delivery and enhanced educational collaboration. Without a doubt, with ICT, learners are able to co-construct knowledge, acquire practical and enriched experiences as they develop high order thinking and problem-solving skills (Madge & O'Connor, 2004). This is actually connected with the fact that ICT forces changes in instructional process, enables easy access to a lot of e-resources, collaboration and activity of groups of learners, and provides the possibility for the teachers to offer individual support to their students(Uibu & Kikas ,2008) . The fact that ICT forces changes in institutional process also particularly empowers learner's lifelong learning chances (Debande & Ottersten, 2004). Nevertheless, the presence of ICT in education and its impact in some cases of primary and secondary education could not be ascertained. With respect to this issue, Rodriguez et al. (2011) attribute the causes of the lack of ICT impact on students' achievement to four major components namely the design and implementation, evaluation procedures, the type of innovations and the cost-effectiveness.

Challenges to attainment of ICT goals

In order to spread and prosper, ICT comes along with broad international, national and institutional goals to achieve such as the Millennium Development Goals (MDGs), Educational For All (EFA) Goals, individual country economic and political visions. Hence, as any other initiative or will to fulfill, ICT is continually facing numerous challenges to its achievements. In line with the above, Banwell et al (2004) point out limited skills, resources and time. Particularly in the African contexts such as the one of Zimbabwe investigated by Mpofu et al. (2013), big national areas are purely rural with limited or no access to computers and electricity. Additionally, African countries still lack basic ICT infrastructure in terms of telecommunication facilities. Teachers who are prime actors do acknowledge poor ICT skills in addition to low motivation and poor remuneration (Mpofu et al., 2013). What is more, ICT goals attainment is associated with cost expressed in terms of limited or even lack of funding (Debande & Ottersten, 2004). Indeed, it is a reality that in developing countries, many ICT initiatives

come on board as projects with external source of funding that locals fail to own and sustain after the external funding has elapsed.

Statement of the problem

Despite the fact that ICT has become an imperative in all kinds of human activities and governments are pushed to embrace ICT in order to conquer the highly demanding, modernized, competitive and fast moving trends of the 21st century, little is known regarding the penetration if the ICT into educational institutions, especially in African countries. Yet, it is known that education is a key sector for any nation as it produces qualified manpower for all other sectors. Hence, one would wonder the extent to which ICT has penetrated this sector and brought about positive impact in developing countries such as Ghana, Kenya and Rwanda that still strive to balance between national priorities, have enough funding for emerging and existing needs while also trying to cope with national and international visions. Factually, even in the developed western countries there are still gaps to bridge in ICT. As an example, while it is well agreed that the prospects of ICT have also a straight impact on the economic growth, in 2001, expenditure on ICT in the European Union was estimated at 4.2% of the GDP while the United States were devoting only 5.3% of their GDP to ICT (Debande & Ottersten, 2004). Hence, a study of this nature was very much inspiring.

Research objectives

This study was guided by the following objectives:
1. Explore the ICT plans and policies in Ghana, Kenya and Rwanda.
2. Find out the ICT initiatives in education, their aims and achievements in Ghana, Kenya and Rwanda.
3. Analyze the challenges to ICT integration in education in Ghana, Kenya and Rwanda and propose remedial solutions

Theoretical underpinnings

This study was inspired by the social cultural theory coined by Vygotsky in the early 20th century. The sociocultural perspectives emphasize the role of the society and interaction in learning and development process which best fit with this study as ICT penetration and impact are very much linked with the human, cultural, social and institutional factors (Goos, 2008). Indeed, ICT being a new tool in modern society, its integration and effective use requires collaboration and interdependence of both social and individual processes which are well described by the Socialcultural approaches (John-Steiner & Mahn, 1996). Actually, the novelty of ICT especially in the developing countries calls for a continuous support from experts and appropriate guidance from more capable peers (Vygotsky, 1978). That is why a realistic assessment of the impact of ICT may only be achieved if one takes into account the broader social context (Barnard & Campbell, n.d). The choice of the sociocultural theory for this study was also motivated by the fact that this theory talks not only about teaching and learning acquisitions (Turuk, 2008) through social interactions referred to as "scaffolding" and "Zones of Proximal Developments (Allahyar & Nazari, 2012) but also emphasizes the importance of relations (Perry, 2012) and mediation of artifacts, activities, and concepts to create new knowledge (Lantolf & Thorne, 2006).

Research Methodology

This study used mixed methods involving quantitative approaches of collecting and comparing quantitative data and qualitative approach involving ethnographic approaches of interviewing key respondents from the Eastern and West African countries to corroborate data collected from secondary sources (Creswell, 2009; Gay, 1992; & Orodho, 2009a, 2009b, 2012). The mixed methods approach designs facilitated collection of the existing literature on the topics on secondary data on ICT penetration and impact in three selected countries which are Ghana, Kenya and Rwanda. The analysis of various official documents and publications has led the research to the past and current visions and policies of Ghana, Kenya and Rwanda in which ICT roles and missions to fulfill were extracted, confronted and discussed. The ICT tools investigated are computers and Internet. The choice of these countries was motivated by the fact that they are among the top African developing countries which are registered among the leading in ICT innovation and use. Hence, their experiences may inspire not only the rest of the continent but also the rest of the world. Additionally, these were the countries of which authors had enough background and hence could objectively assess the progress made and point out the gaps to be bridged. The findings were put under four major themes to enable ample and clear discussion.

Findings

Country visions, policies and ICT role

Ghana

The Government of Ghana places a strong emphasis on the role of ICT in contributing to the country's economy. The country's medium-term development plan as captured in the Ghana Poverty Reduction Strategy Paper (GPRS I&II) and the Education Strategic Plan 2003-2015 all suggest the use of ICT as a means of reaching out to the poor in Ghana (Mangesi, 2007). Republic of Ghana (2003) presents the vision for Ghana in the information age. The policy statement fully takes into account the aspirations and the provisions of key socio-economic development plans undertaken in earlier times. The Policy Statement prescribes the roadmap for the

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development of Ghana's information society and economy and provides a basis for facilitating accelerated national development (Republic of Ghana, 2003). The main objective of the policy is to initiate and sustain an ICT led socio-economic development process with the potential to transform Ghana into a middle income information-rich, knowledge-based and technology driven economy and society. The ICT Policy has been passed by Parliament to be implemented (Amkomah, 2004). The policy has four year rolling plans and an operational life span of between 15 to 20 years. The 14 priority areas of the Policy would concentrate on promoting rapid ICT physical infrastructure development, modernizing agriculture and facilitating development of the private sector (Republic of Ghana, 2003). The priority focus areas of the policy include accelerated human resource development, promotion of ICT in Education (i.e. the deployment and exploitation of ICTs in education), facilitating the government administration and service delivery (promoting electronic government and governance), facilitating the development of the private sector, scientific and industrial research capacity development and developing an export-oriented ICT products and services industry (Republic of Ghana, 2003).

Kenya

The Republic of Kenya (2006), Kenya ICT Authority (2014) and Kandiri (n.d) draw attention as to how the Government of Kenya has shown awareness and move in that ICT has a significant role in gearing the socio-economic and political development of Kenya as embedded in the country Vision 2030. In this respect, the Government of Kenya drafted its first National ICT Policy in 2006. As rightly stated by the Republic of Kenya (2006), Kenya ICT Authority (2014) and Kandiri (n.d), the policy envisions a prosperous ICT-driven Kenyan society, while its mission is to improve the livelihoods of Kenyans by ensuring the availability of accessible, efficient, reliable and affordable ICT services. All the above was because there was need for a comprehensive policy, legal and regulatory framework to support ICT expansion, investment and application, promote competition in the industry where appropriate; ensure affordability and access to ICT nationally, address issues of privacy, e-security, ICT legislation, cyber crimes, ethical and moral conduct, copyrights, intellectual property rights and piracy, support research and development in ICT and develop an institutional framework for policy development and review.

More to point out is that the country's ICT Policy was accompanied by an ICT Master plan in 2014. The ICT Master Plan aims at laying a basis for Kenya transition to a Knowledge Society and positioning the country as a regional ICT hub and facilitating the achievement of socio-economic growth and Vision 2030 targets and extending stakeholders' participation taking into consideration changes in the Jubilee digital Government (Kenya ICT Authority, 2014). The Master Plan not only identifies the driving forces and envisioned outcomes by 2017 and objectives but also strategizes for the realization of the objectives. It also identifies the flagship projects to be implemented in the five coming years namely enabling legal and regulatory framework, persons data hub and associated systems, assets data hub and associated systems, national spatial data infrastructure (NSDI) and associated systems; affordable and quality broadband infrastructure to underserved areas. It also envisions five Centers of Excellence in ICT education and training, 1-2 year intensive structured training and attachment program producing 500 high-end ICT graduates per year, school network, health network, Science & Technology park and an ITES centre in Konza Technocity connected to other innovation hubs, national electronic single window system, national payment gateway and national agriculture commodity exchange (Kenya ICT Authority, 2014).

While the Master Plan pillars are E-Government services, ICT as a Driver of Industry and the Development of ICT Businesses; the foundations of the this Master Plan are ICT human capital and workforce development, Integrated ICT infrastructure and Integrated information infrastructure. Therefore, with the implementation of the ICT Master Plan the expected outcomes include among other things 8% ICT contribution to GDP, Creation of 180,000 direct jobs, 37 successfully commercialized ICT applications with at least two transformative. Besides the above, the implementation of the ICT Master plan also expects ICT companies to establish two commercialized application transformative of which will have a customer base of over 5 million, improved global competitiveness by moving up 15 points on GII, e-Government and NRI ranking, Recognition of Kenya as a regional ICT hub, increased public value of e-Government services with 50% of adults' access to at least one e-Government service and ICT classified as a standalone economic sector by the year 2016.

Rwanda

For the case of Rwanda, Harrison (2005) presents this country as small and landlocked East African nation with about 90% of its population living on subsistence and pure consumption of agricultural activities likely little less and less productive due to soil degradation. Natural resources and exports are few, with 340 people per square kilometer; which ranks this country as the first in Africa and the 21st in the World in terms of the density of the population. In view of such a challenging situation, the new vision of the country is to base its economy on human capital by building a "knowledge-based" economy (Harrison, 2005) whereby information and communication technologies play the prime role.

Rightly turning to Farrell (2007), one finds out that through a number of goals put in place since 1998, the Government of Rwanda is committed to transforming the country to the extent of reaching the status of middle income status by 2020. In this respect, ICT, apart from being a key sector itself, it is to be exploited to be at the heart of the required modernization of all other sector. In education, ICT is expected to be not only the source of knowledge but also the facilitator of access to cheap, fast and updated education (Rwanda Development Board, n.d). In reality, the Government of Rwanda is committed to making ICT a leading tool towards industrialization, socioeconomic development and attainment of global competitiveness (Republic of Rwanda, 2012). That is why since the year 2000 this nation has put in place institutions, legal and regulatory framework, mechanisms and infrastructure and has even funded human resource skills acquisition initiatives in ICT related matters (InfoDev, 2013). The Rwandan leading policies are grouped into long-term economic development plan expressed through the Vision 2020 (MINECOFIN, 2000), the Economic Development Poverty Reduction Strategy (EDPRS), and the National Information and Communications Infrastructure (NICI) Plan (Government of Rwanda, n.d). The adopted ICT for Development (ICT4D) roadmap is presented in four NICI stages as per figure 1 :

Figure 1: Rwanda ICT For Development (ICT4D) roadmap
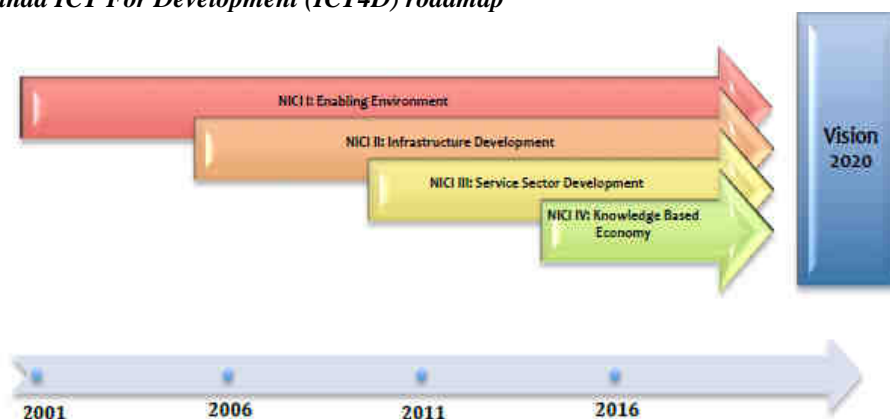
Source: Republic of Rwanda (2012).

ICT in educational institutions
The political will to embrace ICT has been translated into an imperative for educational institutions to adopt, adapt and use ICT.

Ghana

Education plays a pivotal role in the development agenda of various nations and Ghana is not an exception. Ghana's education system has produced many great scholars over the decades who have, and continue to compete satisfactorily with others all over the world (Opoku-Agyeman, 2014). She stresses further that, spite of the successes attained over the years, there is the need to reflect on current changes brought about by the digital age, and be abreast with the times for sustainable national economic and human development. This could be achieved through an Information Communication Technology-driven educational system which must focus on proper development of the required instructors and infrastructure for successful e-learning education (Opoku-Agyeman, 2014).

The role of Information Communication Technology (ICT) in Ghana's education sector cannot be over emphasized. The formulation of Ghana's ICT in Education policy dates back to the year 2006. It however became a legal working document in the year 2008. The Republic of Ghana (2008) asserts that the government has acknowledged the need for ICT training and education in the schools, colleges and universities and the improvement of the education system as a whole. The government was of the view that deployment of ICT into Education would result in the creation of new possibilities for learners and teachers to engage in new ways of information acquisition and analysis. It emphasized the fact that ICT would enhance access to education and improve the quality of education delivery on equitable basis (Republic of Ghana, 2008). The policy stresses the government's commitment to a comprehensive programme of rapid deployment and utilization of ICT within the Education Sector to transform the education system and thereby improve the lives of the people. It is the government's desire that through the deployment of ICT in Education, the culture and practice of outmoded memory-based learning will be transformed to education that arouses thinking and creativity essentially to meet the challenges of the 21st Century (Republic of Ghana, 2008).

According to Ghana's current Education Reform (2007), Information Communication Technology (ICT) plays a key role in broadening access to education to a wider section of the population and literacy education for expediting educational delivery and training at all levels (Republic of Ghana, 2008). The Education Reform highlights ICTs as an important cross cutting issue in the sector, and aims at addressing this through several strategies including equipping all educational institutions with computer equipment and ICT tools in a prioritized manner, implementing ICT programmes at the pre-tertiary level in a phased approach, starting with schools already possessing adequate laboratories and teachers and then gradually expanding to other schools as and when ICT equipment and teachers become available, and adequately resourcing computer science and IT departments in public tertiary institutions to enable them to produce skilled human capital to meet the requirements of the industry (Republic of Ghana, 2008).

Within these reforms, it is also expected that the introduction of ICT into schools should cover teaching of ICT skills to all students, preparing students for the ICT professions and enhancing teaching and learning through ICTs. The tertiary education sector of Ghana's education system is the most advanced in the deployment and use of ICTs in the country. All the country's main universities have their own distinct ICT policies, which include an ICT levy for students. This enables students to have access to 24-hour computer labs with broadband connection. Worthwhile, it is important to stress however that there are instances where the computer facilities are run purely by the private sector such as cyber cafés on campuses because not all tertiary institutions in the country are equally endowed (Mangesi, 2007).

In the basic and secondary education sector, a project to set up computer laboratories in all science schools in the country has led to a significant number of computers being installed across the country. As far back as the year 2006, a computer levy of ¢30,000 (GH¢3.00) was allowed to be charged in most senior high schools (Mangesi, 2007). This enabled a lot of such schools to establish and furnish their ICT centers with the minimum facilities required to facilitate the attainment of basic ICT skills. A great disparity however exists between public and private schools as well as between urban and rural areas in access to ICT. In schools where ICTs exist, teachers are encouraged and actually use the internet for research. Other tools such as smart boards and projectors are also available in such schools. It is equally worth nothing that donations from individuals and groups such as old students, Parent Teacher Associations (P.T.A's) and NGOs, play pivotal roles in ensuring the realization of the utilization of ICTs in the education sector (Mangesi, 2007).

Kenya

In Kenyan system of education, the use of ICTs to support the curriculum dates in the early 1961s through the school radio broadcast. The audio-based curriculum content was developed by the current Kenya Institute of Curriculum Development (KICD) formerly Kenya Institute of Education (KIE). The application of ICTs is more and more gaining prominence in the facilitation of both administrative and pedagogical functions in education institutions. The emergence of mobile phones and recently smart phones has greatly transformed the perception and use of technology at personal, institutional, national and levels. Presently, students and teachers have easy access to educational resources through the internet at the comfort of their laptops, smart-phones and other communication gadgets. Distance learning and e-learning have become a critical mode of delivery and assessment in institutions of higher learning in Kenya (Republic of Kenya, 2006).

There is quite a wide range of use of computers in the schools and colleges. However administrative use and examination processing remains the most frequent followed by teaching of basic computer skills. It was also found that a few schools purchased schools management software used with varying success. Most felt unsupported with lack of training on sue of management software. The most common modules bought by schools were examination, timetabling and accounting modules (Oloo, 2009). With respect to courses offered using the computers, training on basic computer skills remains the most popular among secondary schools and technical training college followed by Kenya National Examination Council (KNEC) curriculum. Most schools have computer literacy courses offered to students and staff. However, though the schools indicate that they have computer literacy policy for all students, the student to computer ration as shown elsewhere in this report does not favor this policy (Oloo, 2009). Rightly turning to the source of computer acquisition, most schools acquire computers either through donation from the government and or Non Governmental Organizations (NGO) or school fund, the government being the main donor of funds for computers. Computers for Schools in Kenya (CFSK) have made an impressive distinction by contributing computers to schools. School funds are normally internally generated incomes by the school or levies introduced by schools' management for buying computers. Parent Teachers Associations also contribute a significantly to 16.07% schools (Oloo, 2009).

With reference made to Oloo (2009), students, teachers and school administrators have favorable attitudes towards ICTs. Quite a lot of schools deploy their efforts to promote computer literacy among teaching staff. Most the trained teachers are trained in basic computer courses and are useful for basic first line support

functions. The study found that 100% of teachers deployed to computer in the schools have received some basic training in computing. Most teachers view computers as an important tool for motivating students (82.29%). A lot of views are that computers are exceptional gears for supporting teaching (76.79%), computers help learning (37.5%). Internet connectivity was also cited by the teachers as a need (30.36%). The schools also acknowledged that administrative functions have been enhanced by the computers (26.7%).

Rwanda

In Rwandan context, the adoption of ICT in education policy was followed by sub-plans which were progressively updated and revised since 2000 and culminated into the implementation strategies incorporating mainly the need for primary and secondary teachers' training in ICT, the development of e-learning content and educational management system (EMIS), the provision of computers in schools and Internet for excellence schools, the fast move into the purchase and installation of ICTs in higher education institutions among many others (Farrell, 2007). Certainly, apart from the fact that all higher learning institutions, be it public or private, have fast embraced ICT as an educational and managerial tool, a specific public higher learning institution named Kigali Institute of Science and Technology (KIST) was created with a clear mission to produce IT engineers and scientists (Harrison, 2005) that would meet the national human resources needs. Undoubtedly, ICT has become not only a field of study but also a tool that support formal instructional activities in Rwandan secondary schools and higher learning institutions, (Ndayambaje & Orodho, 2014) and quality enhancement mechanisms (Ndayambaje & Ngendahayo, n.d).

As a matter of fact, while in 2000 just one school in Rwanda had a computer, six years later, which is towards the year 2006, 400 secondary schools were already equipped with computers 39 of them having wireless Internet access and over 2,000 teachers had been taken to ICT related training while the One Laptop Per Child (OLPC) project was also being brought to benefit primary schools. The first attempt with OLPC in Rwanda was made in 2007 after which about 80,000 XO computers were deployed in primary schools. In the year 2012, more than 100,000 devices were also planned to be distributed across the country and teachers thought to be trained on how to work with students using the laptop. Furthermore, many ICT in education projects came in to support the Ministry of Education and specific educational institutions to fulfill their ICT goals. Some of these are SchoolNet project which intended to be the vehicle for school connectivity, Microsoft which committed to enable the use of its softwares in Rwandan schools at a significantly reduced annual fee, the Rwanda Education and Research Network (Rwednet) which was expected to enable the broadband access for all higher education institutions and research centres (Farrell, 2007).

Also important to note is that in higher learning institutions, the partnership of former Kigali Institute of Education (KIE) now University of Rwanda-College of Education (UR-CE) with Indian World class universities such as Indira Ghandi National Open University, University of Madras to name just a few has led to the opening up of e-learning programmes (teleeducation) which enables Rwandan students and other partnering Africans in the Pan African network project to undertake diploma, bachelors, postgraduate diploma and master's degree courses being in their respective countries in a flexible way and at a relatively little operational charges (Ndayambaje, n.d). As far as ICT in education in Rwanda is concerned, in his official three-year plan, the new Prime Minister Mr. Murekezi Anastase has communicated his government that in addition to the enforcement of One Laptop Per Child (OLPC) initiative, each school is expected to have an ICT center/laboratory, 30% of the instructional activities in secondary schools will be ICT-led while in higher learning institutions 50% of the programmes will be delivered using smart classrooms, digital content, Open distance and E-learning (http://www.igihe.com/amakuru/u-rwanda/article/minisitiri-w-intebe-murekezi-54555?page=article_mobile).

Progress and challenges in the implementation of ICT

Despite the observable achievements in ICT in general and ICT in education in particular, the journey to go is still long. Ghana, Kenya and Rwanda do still acknowledge the African realities which hamper the speed of their advancements.

Ghana

Before the year 2000, Ghana as a developing nation had very little to show in terms of the strides made in its quest for the adoption of the Information Communication Technologies (ICTs) in various phases of its national development. Past and present governments of Ghana and other agencies have made various efforts to develop the ICT infrastructure over the years, with the aim of bridging the digital divide between Ghana and the developed World. The development of a national fiber optic network (Voltacom Project) by the nation's power house- Volta River Authority (V.R.A.) is one of such bold steps (Ankomah, 2004).

It is worth noting that Ghana became the first country in Sub Saharan Africa to have full internet connectivity in 1995 (Ankomah, 2004). In the year 2003, Ghana's National ICT Development Policy was drafted and passed

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into law by parliament. This policy spelt out clearly the nation's vision with regards to inculcating ICTs into various facets of the nation (Ankomah, 2004). In the same year, the Government of Ghana in Collaboration with the Indian government established and commissioned the Kofi Annan ICT Centre of Excellence to produce the human capacity needed for the emerging ICT industry in Ghana and the West African sub-region. Additionally, the government continues to allocate funds in the national budget on yearly bases to expand the ICT infrastructural capacity to accommodate the ever-increasing demand for the adoption and use of ICTs, especially in the remote parts of the country (Ankomah, 2004).

The Ministry of Education Superintended over the drafting of the "ICT in Education Policy" in 2006 which became operational in the year2008 to ensure a full realization of the adoption and benefits of the ICT in the education sector .This policy outlined the strategies, implementation procedures and modules to guide the development and deployment of ICTs across the education system (Mireku et al, 2009).The adoption and use of ICTs is gradually getting integrated in various sections and levels of the education sector in Ghana. At the basic level, the government initiated discussions on the One Laptop per Child (OLPC) project since the year 2007. This project aims at providing each basic school child with a personal laptop to enhance the desire of the children in computer technology at the very early stage of their lives. Also, ICT now forms a major subject component of the basic school curriculum, though not yet externally examinable. Quite a number of basic schools, especially private ones have well equipped computer laboratories to enhance the study of Information Communication Technology in these schools (Buchele & Owusu-Aning, 2007).

In secondary schools, ICT is taught as a subject that is internally examinable, with most secondary schools having well equipped laboratories to support computer studies, especially grade 'A' schools. Worth to note again is that Ghana now has ICT syllabuses/manuals; there is the availability of computers and computer laboratories that can be accessed periodically by teachers who are willing to provide educators and learners with training. Most secondary schools, especially those in the urban areas have fully inculcated ICTs in their school management systems. Generation of students' bills, academic reports, library and dispensary services are some of the services provided with the aid of ICTs in Ghanaian schools (Mireku et al, 2009).

The above positive developments notwithstanding, the implementation of ICT and the realization of its intended purpose in Education has had and continues to face its fair share of challenges. Like many other parts of Africa, the internet and computing component of the ICT revolution in Ghana was left behind. This has resulted in significant differences in the urban and rural access to ICTs (Mangesi, 2007). Unreliable power supply, limited number of computers and computer labs in schools as well as network challenges continue to hamper the integration of ICT in Ghana's education sector. Again, frequent breakdown of computers, teachers' poor knowledge in the use of ICT in the teaching-learning process and lack of resources such as projectors, and specialized computer softwares for teaching the various subjects remains major drawbacks to the utilization of ICT in the education sector (Mireku et al, 2009).

Kenya

Undoubtedly, there has been a remarkable conversion in use of the ICT in the Kenyan context. This has been accompanied by the general awareness of the effectiveness of ICT in service provision. Among other progresses to note, the country is now connected to the international broadband highway through the SEACOM, TEAMS, EASSY, and LION undersea fibre cables. A Government Common Core Network (GCCN) has been developed to serve as a shared and secure interoperable Government-wide ICT architecture, integrate work processes and information flows, improve the inter-ministerial sharing of databases and exchange of information to eliminate duplication and redundancies, improve public access to Government services and ensure responsiveness in reporting, monitoring and evaluation (Kenya ICT Authority, 2014).

The Kenya ICT Authority (2014) rightly avers that most major towns in Kenya are connected through the National Optic Fibre Backbone Infrastructure (NOFBI), which is to be extended to all parts of the country by additional links and wireless broadband network to enhance redundancy. The tier to Government Data Center (GDC) infrastructure has been put in place to ensure security of Government data and applications. Bandwidth support to Government offices has been steadily growing. Furthermore, disaster recovery facility for data and systems as part of the business continuity plan has been being developed. Making reference to The Kenya ICT Authority (2014), it turns out to be noticeable that the Government of Kenya has implemented electronic systems in various State Departments and other state-owned institutions, including national tax systems, immigration information system, legal information system, the integrated financial management system and education system. Exemplarily, these systems are to be found in the National Treasury, Kenya Revenue Authority, Home Affairs State Department and Immigration Office. In addition, information is exchanged among departments and institutions by means of fax, e-mail and electronic media. These systems provide partial electronic services to citizens and businesses through Government portals. Most Governments at this level have begun developing

County ICT Master Plans, which are to be aligned to the national one. At the ministry level, all departments have been mandated to use Integrated Financial Management Information System (IFMIS).

The achievements have made Kenya one Africa's finest in ICT innovators with mobile money transfer services, which led to o increased financial inclusion. Recently, explosion of local ICT development groups such as iLab, iHub, Nailab, University of Nairobi's C4DLab and infoDev's mlabs in Kenya has enhanced innovation of applications of information services like Drumnet, mFarm, Ushahidi, etc. Over the years, Kenya has hosted multiple African Regional hubs amon others IBM's first African Research lab, Nokia's Africa Headquarters and Google's first Sub-Saharan Africa office. In comparison with two countries in the lower middle income (Ghana and Senegal), two countries in the upper middle income (South Africa and Brazil) and one country in high income (Portugal), Kenya has shown competence for innovation (Kenya ICT Authority, 2014).

Although the above achievements, there has been a numberless challenges that affect use of ICT in our institutions. These include a lack of ICT-skilled personnel; a lack of adequate ICT equipment; a lack of reliable electricity/source of electric power; cases of burglary/insecurity; fear arising from the misconception that that ICTS will end-up replacing teachers in the classrooms as well as the general techno-phobia among teachers and administrators (Karsenti et al., 2012)). While institutions emphasized the provision of infrastructure, investment in human capital required to operate those ICTs has almost been ignored (Kenya ICT Authority, 2014). Additionally, there is a challenge of discrepancies in computers owned by the school. The findings have shown that the number of computers in schools varies widely from one school to another. Statistically, 17.9% of schools (10) had less than 5 computers. 46.4% of schools had 20 or less schools while 62.5% had l30 or fewer computers, which lead to a big student computer ratio and school still do not afford enough funds to purchase computers. Majority of schools (25.9%) have to outsource maintenance services while 3.7% use CFSK supports. Majority of schools (58.9%) examined lack Internet connectivity (Oloo, 2009).

Rwanda
Towards the year 2003, ICT in Rwanda was at embryonic phase; ICT infrastructure were rare to the extent that Internet density was just 0.06%, citizens' awareness of the potentials of ICT was very low, skilled IT tech men could be easily counted (Republic of Rwanda, 2008). More than 10 year now, Rwanda has grown fast and that is the reason why it is among the African leading countries in ICT area. Factually, the political will was rapidly translated into substantive, coordinated and monitored actions that culminated for instance in the fact that in 2010 Rwanda was nominated top global reformer in the World Bank Doing Business report and second global reformer out of 183 examined countries in 2011 (Republic of Rwanda, 2012).

The strives that Rwanda has made in ICT both in education and other sectors have been exceptional to the extent that Rwanda is recognized as being role model in ICT in sub-Saharan development and still no other country is competing besides South Africa, which has substantial natural resources (Harrison, 2005). Currently, a 2,500 km Fiber Optic backbone that connects all 30 districts is already operational and in 2006 the government devoted one billion dollar to build nationwide tele-centers with Internet and telephone access points, allowing an increased connectivity in rural areas. Furthermore, Rwanda has been named East Africa's number one ICT nation by the United Nations Conference on Trade and Development (UNCTAD) (Rwanda Development Board, n.d)

However, the Rwandan ambition to achieve high is still challenged by social and economic transformation (InfoDev, 2013), galloping demography coupled with endemic poverty (Republic of Rwanda, 2008), the availability of sufficient well trained local manpower, the coverage of Internet and availability of electric power to the entire territory (Farrell, 2007), the big gap between ICT availability between rural and urban areas (Rwanda Development Board, n.d), insufficient ICT equipment in relation to the growing number of students (Ndayambaje & Orodho, 2014) and the limited teacher training and attitude (Debande & Ottersten, 2004). Really, ICT has not yet been at the centre of delivery of local distance learning programme (Ndayambaje et al., 2013) which may affect learners' support and taking advantage of the modern learning environments (Ndayambaje, in press).

Conclusion and recommendations
The thrust of this study was to comparatively examine the Information Communication Technology Penetration and its Impact on Education, by drawing lessons of experience from selected African countries of Ghana, Kenya and Rwanda. It is concluded Ghana, Kenya and Rwanda are among African countries that have unequivocally demonstrate political and institutional eagerness to embrace ICT as a developmental, economical and social transformational tool in order to attain national and international goals. However, the discrepancy resides in the particularity of each of them in terms of national priorities, leadership, history, infrastructure, economy and readiness of the partners among others where Rwanda seems to be taking the lead. It is also

concluded that these three countries have been beleaguered by myriad of intertwined challenges related to attitude, inadequate financial allocation to sustain the technology and fairly low level of personnel to handle the ICT in educational institutions and key government ministries.

From the findings and discussions, is recommended that most African countries, especially Ghana, Kenya and Rwanda should:

1. Allocate adequate budgetary allocation to ICT development in order to enhance skills and infrastructural development, monitor of the ICT project, and avail ICT hardware and software at a satisfactory level in all sectors in general and in educational institutions in particular.

2. Allocate more funds for enhancing the teachers' professional competence in ICT usage and development; motivate their readiness to embrace ICT in educational initiatives.

3. Ensure that there is adequate institutional and political support and enforcement of ICT regulatory framework and bring on board all potential partnerships to foster their active participation in all possible means.

4. The shortage and high cost of ICT infrastructure and tools should be addressed through the partnership and collaboration with international agencies and specialized companies which are also targeting the African growing market. In this way, these African countries' dream to become middle income nations will become a reality following the example of Singapore of which economy is knowledge-based and where ICT has been the basis for all achievements till today .

5. It also proposes that countries learn from one another in terms of achievements made and challenges overcome.

6. Last but not least, the study proposes further research in and hence complement and fill the possible gaps   and realities on the ground that could have been created by this study.

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