



# Using Information and Communication Technology (ICT) to Improve Polytechnic Education in Ghana

Nana Yaw Asabere

Computer Science Department, School of Applied Sciences and Arts, Accra Polytechnic, Accra, Ghana  
yawasabere2005@yahoo.com

**Abstract**— In the past decade, there has been a tremendous growth of Information and Communication Technology for Education (ICT4E) in the West African sub region and the African continent as a whole. Through the support of both international and local development agencies, several Higher Education Institutions (HEIs) in Ghana have engaged in introducing, implementing and supporting ICT4E. Using a review of existing and relevant literature, this study aims at providing a description, analysis and guide of how Polytechnics in Ghana can use ICT to improve their education and make such enhancements a reality. Furthermore, the study aims to propose two considerable and adoptable frameworks that can be incorporated as implementation strategies by various Polytechnics in Ghana. Such ICT frameworks will pave the way for the successful implementation of ICT4E in Polytechnics in Ghana.

**Index Terms**—HEIs, ICT4E, Infrastructure, Policies, Polytechnics, Ghana and ICT4AD

## I. INTRODUCTION AND BACKGROUND OF STUDY

ONE of the most important sectors for developing the human capital of various countries worldwide is higher education. Through the successful development of human capital, higher education enables various countries to support innovation and find new solutions for sustainable and equitable growth [1].

According to InfoDev [2], ICT can be used to improve the quality of education by increasing access to education for teachers and students via distance learning, e-learning, enhancing educational content development and supporting administrative processes in schools and other educational establishments. Consequently, ICT can accelerate national development by improving governance and contributing towards a country's participation in the global knowledge economy [1].

The Polytechnic Education sector of Ghana has grown tremendously in the past two (2) decades. Currently the Polytechnics in Ghana are ten (10) in number, namely: Accra, Bolgatanga, Cape Coast, Ho, Kumasi, Koforidua, Sunyani, Takoradi, Tamale and Wa Polytechnics. Most of these Polytechnics, e.g., Accra, Kumasi, Ho and Takoradi

Polytechnics were initially established as Technical Institutes in the 1940s. Through the enactment of the Ghana Polytechnic Law of 1992 (PNDC 321) which became fully operational in the 1993/1994 academic year, various Polytechnics such as Accra, Kumasi, Takoradi and Ho were initially elevated to tertiary status with the rest following as the years went by. As a result of this enactment, the Polytechnics in Ghana were placed under the Higher Education Council with the autonomy to award Higher National Diplomas (HNDs) through the National Board for Professional and Technical Examinations (NABPTEX), Ghana [3].

Polytechnics in Ghana have a mission of providing life transforming opportunities and experiences for students through teaching, research, practical training and entrepreneurial skills development in the fields of Applied Sciences, Applied Arts, Technology, Engineering and Business for the society. Furthermore, Polytechnics in Ghana have a vision of becoming centres on excellence for Teaching, Practical Training, Research and Learning [3].

The above missions and visions of Polytechnics in Ghana can be achieved through successful implementation of ICT4E. According to the 2003 Ghana ICT for Accelerated Development (ICT4AD) Policy [4], Ghana has a relatively high proportion of the population with no educational attainment, a high school drop-out rate and limited access to higher education by the vast majority of the population, especially girls and women. The Ghana ICT4AD Policy was therefore designed to aid Ghana's development process by contributing to the addressing of developmental challenges such as the one described above.

In order for educational challenges of the population to be addressed, the Ghana ICT4AD Policy states that ICT has a major role to play in various tertiary institutions in the country. The HEIs in Ghana, which include the Polytechnics, have to support the Ghana ICT4AD Policy by aligning with its specific objective in terms of education i.e. to promote an improved educational system within which ICTs are widely deployed to facilitate the delivery of educational services at all levels [4].

The 2003 Ghana ICT4AD Policy [4], further states that Ghana has a high illiteracy rate, with close to 40% of the population above the age of six (6) years not having any form of educational attainment, and only 3% of the population having tertiary level of education. This is having serious

implications on the nation's development. Therefore Polytechnics and other HEIs in Ghana have to enhance social education services to ensure quality and locational equity.

There are discrepancies about the effectiveness and impact of ICT, but all stakeholders in Ghana agree that education is one of the key factors for the development of a country. Many researchers and international development aid agencies have accentuated that education is one of the main pillars for development, especially for poor countries [4]-[7].

Through relevant review of existing literature, this paper has an objective of describing, analyzing and guiding how Polytechnics in Ghana can use ICT to improve their education and make such enhancements a reality. Furthermore, the paper aims to propose two considerable and adoptable frameworks that can be integrated as implementation strategies by various Polytechnics in Ghana.

The rest of the paper is organized as follows. Section II discusses How Polytechnics in Ghana can Enhance Education through ICT, Section III presents Factors Polytechnics in Ghana Should Consider for Successful Implementation of ICT in Education and Section IV presents a Research Discussion and Analysis. The paper is finally concluded with a recommendation in Section V.

## II. ENHANCEMENT OF EDUCATION THROUGH ICT BY POLYTECHNICS IN GHANA

The enhancement of education through ICT by various Polytechnics in Ghana requires policies that involve the ICT contribution of teachers, staff and students. All stakeholders of Polytechnics have a role to play if ICT implementation will be successful. Relevant issues such as teacher-student ratio, number of staff/lecturers and the procurement of appropriate and relevant ICT infrastructure involving the requisite hardware and software have to all be taken into consideration by Polytechnics in Ghana.

For example in Accra Polytechnic, all offices/departments within the Administration Block are equipped with Personal Computers (PCs) that have high/standard specifications and are connected to either a wireless or wireline/cable internet connectivity through a main Polytechnic server. Additionally, the offices of most teaching staff are equipped with internet connectivity, some of the classrooms are equipped with LCD projectors to enhance ICT teaching and learning and finally there are four computer laboratories that are equipped with a total of approximately 260 computers, which are used to serve the ICT and computer literacy needs and requirements of students as well as staff.

In line with the Ghana ICT4AD [4], Accra Polytechnic's current ICT situation, which is successful in comparison to past years can further be improved though more enhanced ICT infrastructure involving both hardware and software, increased bandwidth for the internet connectivity as a result of the increase in population of staff and students and consultative procedures to enhance the ICT pedagogy and competency/skills of teachers and students. This analogy in relation to that of Accra Polytechnic can be adopted by other sister Polytechnics through rigorous observation of their current ICT situation with a focus on how they can further improve their education (teaching and learning) through ICT.

Furthermore, the pedagogic procedures of teaching and learning through ICT have to be adopted by teachers and learners respectively. Initially teachers have to adopt ICT procedures of teaching to improve their pedagogy. This concept can then be transformed to students. The ICT competency and skills of both teachers, students and staff should be upgraded [8].

The Sourcing of funds by various Polytechnics from the Government of Ghana (GoG) to procure ICT equipment is not an easy task. However, due to the design of the Ghana ICT4AD [4], the GoG through various agencies and companies has made it a priority to help all HEIs procure the needed equipment in order to make ICT in education at all levels sustainable.

It is acknowledged that for Ghana to make any appreciable progress in its socio-economic development efforts, sustainable resources are needed to reduce the percentage of the population without educational attainment. This will widen the access to tertiary/higher education by the vast majority of the population and hence increase the percentage of population with tertiary level education [4].

Consequently tertiary institutions in Ghana have to promote enhanced ICT educational modes such as electronic learning (e-learning) and mobile learning (m-learning) in order to serve the needs of the Ghanaian citizens who cannot get access to onsite education at Polytechnic campuses as a result of insufficient educational resources.

E-Learning and m-learning systems/ platforms that are deployable in Polytechnics should involve the appropriate ICT infrastructure and equipments such as modern PCs for e-learning and current mobile devices/phones for m-learning as well as the appropriate network infrastructure and internet connectivity for effective teaching and learning. Various Learning Management systems (LMS) that are characteristic of the particular ICT mode in education have to also be deployed and installed.

## III. FACTORS TO CONSIDER FOR SUCCESSFUL IMPLEMENTATION OF ICT IN POLYTECHNIC EDUCATION IN GHANA

For some time now, international organizations, researchers and scholars, working in the field of ICT/Computer Science/IT have studied different factors that corroborate to failed and successful implementations of ICT4E in various educational establishments. Depending on the level, the perspective or the focus, the factors of successful implementation of ICT4E can be categorized in different ways [1]. This section of the presents some factors to be considered by Polytechnics in Ghana for successful ICT4E implementation. Additionally, some considerable and adoptable ICT4E frameworks are proposed to be used as strategic guides by Polytechnics in Ghana.

Mumtaz [9] presented an innovative and motivating framework by listing some factors that prevent teachers of various HEIs from using technology as pedagogic tools for teaching. These factors include: (i) lack of financial support, (ii) lack of teaching experience involving the use of ICT, (iii) lack of ICT specialist teachers to teach students computer skills, (iv) lack of time required to successfully integrate

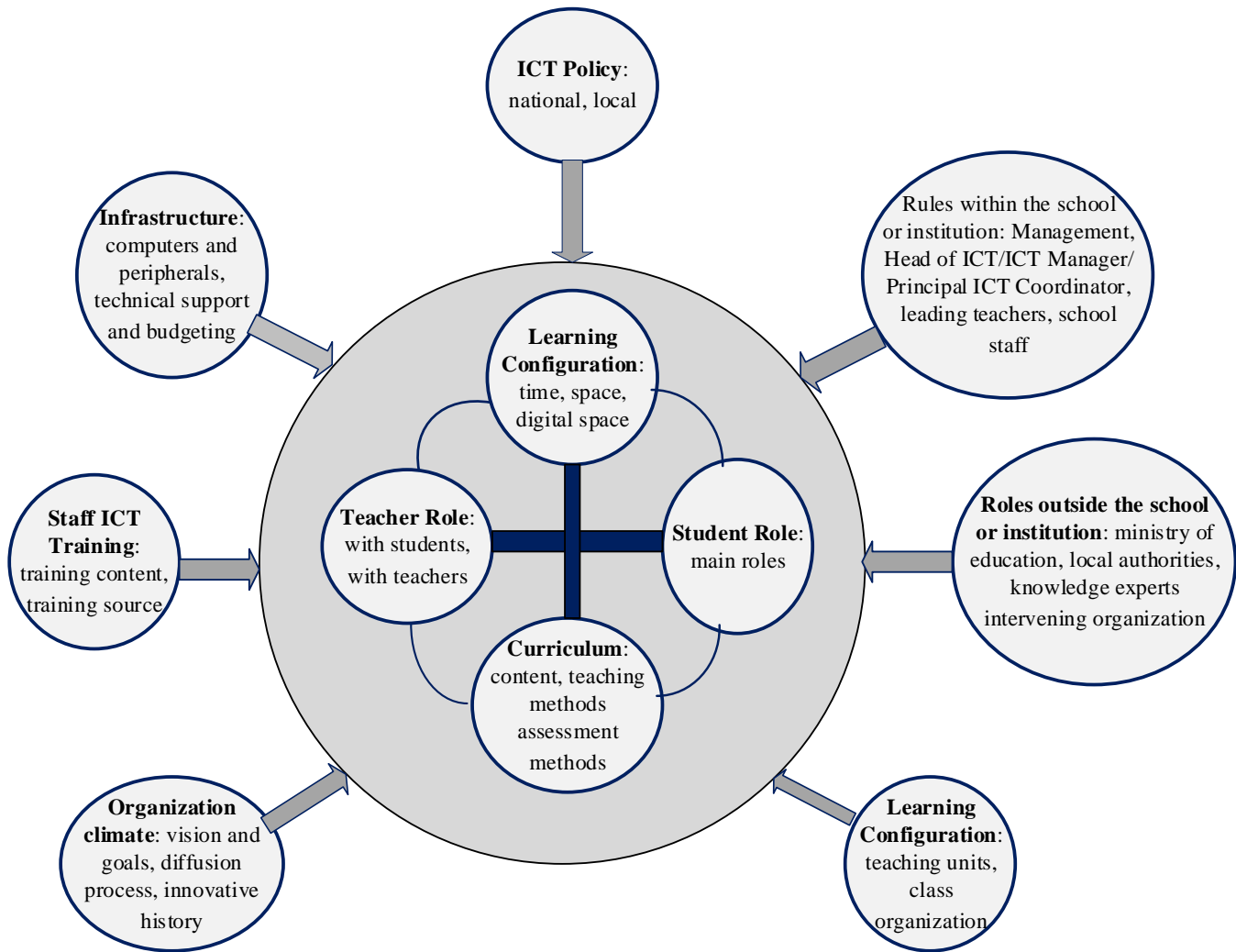


Fig. 1: Configuration of the factors involved in pedagogical innovations using ICT



Fig. 2: Computer Laboratory 3, Accra Polytechnic –100



Fig. 3: Computer Laboratory 2, 50 Computers/Seating Capacities  
Computers/Seating Capacities

technology into the curriculum of various programmes (v) lack of onsite support for teachers using various technological tools involving ICT, (vi) lack of help supervising students when using computers and (vii) unavailability of computers.

All of these constraining factors outlined by Mumtaz [9] are related to the success factors outlined by Nachmias et al. [10]. Nachmias et al. [10] conducted a literature analysis from different studies and found the following factors as successful implementation strategies for ICT in Education: (i) institutional leadership, (ii) allocation of resources by HEIs, (iii) the ICT vision of HEIs and (iv) the organizational aspects of HEIs in terms of ICT. A key difference between the frameworks of [9] and [10] is that Nachmias et al. [10] articulates the requirements for success and Mumtaz [9] summarizes the reasons for failure of ICT implementation.

Furthermore, Hoffman [11] emphasized that successful implementation of ICTs must focus on infrastructure, attitudes, staff development, technical and administrative support, sustainability, and transferability. Nachmias et al. [10] additionally recommended a framework to map the intensity of factors involved in the implementation of innovations using ICT, this is depicted in Figure 1.

#### IV. RESEARCH DISCUSSION AND ANALYSIS

From Section III, the two presented frameworks involving [9] and [10] are considerable and adoptable by Polytechnics in Ghana. This is due to the fact that both frameworks present a variety of factors, and additionally, they provide different perspectives.

With a reflection on the two presented frameworks, this paper analyzes and discusses the most fundamental aspects required for successful implementation of ICT4E. These include: ICT Policies of the GoG and Polytechnics in Ghana, Access and use of ICT4E, Pedagogy, and ICT Infrastructure.

##### A) *ICT Policies of the GoG and Polytechnics in Ghana*

For the past decade many countries in the African continent have been developing and implementing ICT National Policies with a focus on achieving social, economic, cultural and political development. In many developing countries education, (and particularly tertiary education), is seen as one of the most important ways to improve economic growth and alleviate poverty. Thus when a country outlines an ICT policy, education appears as one of the pillars and thrust areas that can lead to enhanced development.

Muianga et al. [1] mentioned that, the government of Mozambique approved a national ICT policy in 2000 and the Strategy for Innovation in Science and Technology in 2002. In 2002, the government of Mozambique approved an action plan that had as its main objective of designing and implementing strategic ICT projects in all sectors and institutions.

As stated previously, in 2003, the Republic of Ghana designed the Ghana ICT for Accelerated Development (ICT4AD) Policy, which was approved by parliament in February 2004. The Ghana ICT4AD Policy characterizes the vision of Ghana in the information age. It is based on the framework document: “An Integrated ICT-led Socio-

economic Development Policy and Plan Development Framework for Ghana”. The development of this policy was based on a nation-wide consultative process involving all key stakeholders in the public sector, private sector and civil society of Ghana [4].

According to [4], the policy statement sets out the road map for the development of Ghana’s information society and economy and provides a basis for expediting the socio-economic development of the country in the emerging information, knowledge and technological age to be dominated by information and knowledge-based economies. The policy aims at addressing a number of developmental challenges facing the country as a basis for achieving a number of policy goals and objectives. In terms of HEIs/tertiary institutions, the Ghana ICT4AD has an objective to: (i) promote basic ICT training in all tertiary institutions, (ii) ensure that all citizens who qualify and enter tertiary institutions in Ghana will benefit from ICT in education and (iii) promote and encourage distance learning and e-learning in all tertiary institutions in order to broaden access to educational and training resource services for a larger section of the Ghanaian society.

In Ghana, ICT has been part of the referential framework of the Ghana ICT4AD Policy and this has influenced the referential frameworks of Polytechnic education in Ghana. However, some ICT problems in Polytechnics still remain i.e. the ICT infrastructure not meeting the ICT demands of staff and students and sometimes lack of a simple website information. In order for Polytechnics in Ghana to improve their education delivery using ICT, they should further formulate their own ICT policies and enhance existing ones using the Ghana ICT4AD Policy as a referential framework to identify their weaknesses in terms of the objectives of the policy (Ghana ICT4AD Policy) and also consult the various stakeholders of the GoG when they face challenges.

##### B) *Access and Use of ICT4E in Polytechnics in Ghana*

According to Plomp et al. [12], access to ICT infrastructure and resources in schools is a necessary condition for the integration of ICT in education. Consequently, effective adoption and integration of ICT into teaching in schools, mainly depends on the availability and accessibility of ICT resources such as hardware, software, etc. Obviously, if teachers cannot access ICT resources, then they will not use them [13]. Norris et al. [14] also mentioned the importance of access to technology for effective adoption and integration by training institutions. Therefore, an understanding of institutional characteristics will influence teachers’ adoption and integration of using ICT in teaching delivery. Kozma [15] emphasized that the use of ICTs for learning encourages inquiry-based learning collaborative work, learner-centered learning and active exploratory sessions among learners and teachers. Accordingly, such affordances of ICTs in education support the development of analytical skills, critical thinking, informed decision-making and creativity.

The introduction of ICT in education is important because of the changes it can have in different aspects of learning. However, the benefits of ICTs for students and staff can only be achieved if the Polytechnics in Ghana ensure access for all

stakeholders, so that ICT can be used in teaching and learning, research and management. For instance in Accra Polytechnic, the management has made hardworking efforts to provide the needed infrastructure for teaching and learning using ICT. Figures 2 and 3 depict two computer laboratories in Accra Polytechnic that are usable and accessible by both staff and students in different laboratories consisting of 100 and 50 computers/seating capacities respectively.

Institutional websites provide important information that can form the basis for quality ranking of Polytechnics in Ghana. The majority of Polytechnics in Ghana have a website. The Polytechnic websites that were accessible at the time of writing this paper are as follows: Accra1, Bolgatanga2, Cape Coast3, Koforidua4, Kumasi5, Takoradi6, Sunyani7 and Tamale8.

Globally, the websites of various HEIs presents the institution as an organization with a specific vision and describes its faculties or schools and academic programmes. Additional information such as admission requirements, academic regulations, student registration procedure, upcoming events and the rights and duties of students and lecturers etc. are also provided as additional incentives by some HEIs.

The currently available Polytechnic websites in Ghana range from rudimentary to advanced, depending on the IT/ICT capacity of each Polytechnic and/or the frequency of information updates. With reference to the websites of Koforidua, Kumasi, Takoradi and Bolgatanga Polytechnics, they are the most advanced in terms of updates and reliable information i.e. they provide more information regarding the faculties, schools and departments as well as current and available news on their home pages, which improves the accessibility of information from the Polytechnics through ICT. The Polytechnic websites of Sunyani, Cape Coast and Tamale are not as advanced as the four above. The Polytechnic websites of Ho and Wa were currently not accessible.

### C) Pedagogy in Polytechnics in Ghana

According to Muianga et al. [1], nowadays, HEIs must play a decisive role in stimulating innovation and knowledge creation in the development of human capacity. In Ghana, Polytechnics provide practical training to students but are challenged with collaborative work involving the usage of ICT skills and problem solving competencies to foster and promote critical thinking skills. Furthermore, Muianga et al. [1] argues that, the introduction of ICT in education can play

a central role in developing the teaching and learning models and in the transformation of the learning approaches from older teacher-centered approaches to more student-centered learning, which develops the skills needed in an increasingly globalized knowledge economy. Despite the development/design of the Ghana ICT4AD Policy in 2003, which recommends that student-centered learning is required by current job market conditions, in most of tertiary institutions in Ghana, ICT pedagogy hasn't been realized to its fullest and hence improving education in Polytechnics through ICT has somewhat not been achieved. Polytechnics in Ghana should be able to move beyond a rhetorical commitment to transforming pedagogy through ICT. This will afford Polytechnics in Ghana greater chances of improving their education through ICT thus introducing different educational modes such as e-learning and m-learning.

### D) ICT Infrastructure in Ghana

Ghana was one of the first countries in Africa to liberalize its telecommunication and ICT sector. Ghana has made tremendous progress in ICT deployment but like many other countries and parts in Africa, the ICT revolution in Ghana has left behind the internet and enhanced computing services. There are also substantial differences in urban and rural access to ICTs [16].

In August 1995, Ghana became the second country in Sub-Saharan Africa to have full Internet connectivity. Ghana is directly connected to the world's first submarine fibre-optic cable system, SAT-3/WASC/SAFE, which links Africa to Europe and Asia. Network Computer Systems Ltd (NCS), one of the first IT/ISP Companies in Ghana, established the first connection. NCS was given its own VSAT (Very Small Aperture Terminal) gateway as a result of the constraints experienced by Ghana Telecom (GT) (now Vodafone Ghana) [17].

Nevertheless, the Internet sector's expansion has been seriously inhibited by a shortage of functional dial-up phone lines. According to [17], by 2002, the National Communication Authority (NCA) had licensed 52 Internet Service Providers (ISPs), although only about ten were operational at that time. Due to the structural adjustment

Table 1. List of Current Communication Service Providers in Ghana

Service Type	Number of Operators
National Fixed Network Operators	5
Wireless Telephony Operators	2
Internet Service providers	92
Direct to Homes Satellite Services	1
VSAT Data Network Operator	114
Free on Air Television Stations	13
Privately-Owned Radio (FM) Stations	154
Pay Per View	3

<sup>1</sup> <http://www.apoly.edu.gh/>

<sup>2</sup> <http://www.bpoly.edu.gh/>

<sup>3</sup> <http://www.cpoly.edu.gh/>

<sup>4</sup> <http://www.koforiduapoly.edu.gh/>

<sup>5</sup> <http://www.kpoly.edu.gh/>

<sup>6</sup> <http://www.tpoly.edu.gh/>

<sup>7</sup> <http://www.spoly.edu.gh/>

<sup>8</sup> <http://www.tamalepoly.com>

Table 2: Mobile Telecom Voice Subscription Trends in Ghana as at January-March, 2013

Mobile Voice Operators	January, 2013	February, 2013	March, 2013
Expresso	212,804	163,762	162,661
Millicom (Tigo)	3,669,472	3,712,082	3,676,457
Scancom (MTN)	11,857,772	11,941,887	12,024,068
Vodafone Mobile	5,423,932	5,551,139	5,609,122
Airtel	3,273,048	3,341,715	3,384,749
Glo Mobile	1,649,767	1,614,117	1,607,907
<b>Total</b>	<b>26,086,795</b>	<b>26,324,702</b>	<b>26,464,964</b>
<b>Month Over Month Growth</b>		<b>0.90%</b>	<b>0.50%</b>

Table 3: Mobile Telecom Data Subscription Trends in Ghana as at January-March, 2013

Mobile Data Operators	January, 2013	February, 2013	March, 2013
Expresso	49,270	49,720	49,270
Millicom (Tigo)	1,220,557	1,251,190	1,288,496
Scancom (MTN)	5,614,411	5,759,418	5,819,634
Vodafone Mobile	511,298	523,938	590,567
Airtel	484,374	811,866	867,386
Glo Mobile	449,010	420,479	280,077
<b>Total</b>	<b>8,328,920</b>	<b>8,816,611</b>	<b>8,895,430</b>
<b>Month Over Month Growth</b>		<b>5.80%</b>	<b>0.90%</b>

programme in Ghana and the open economic policy of the government, the telecommunications sector embarked on a programme of privatization in 1994.

ICT infrastructure in Ghana is progressing better than other low-income countries and above the 1.1% average for Sub-Saharan Africa [18]. As mentioned above, The GoG has, since February 2004, enacted the 2003 ICT4AD Policy with 14 priority areas. The thrust of the policy is to primarily concentrate on promoting ICT physical infrastructure development, which will in turn expedite the development of the private sector [18].

According to GIPC [18], it is heartening to note that in 2009 Ghana was ranked as the most preferred business destination in Sub-Saharan Africa for Business Process Outsourcing (BPO) in the AT Kearney Global Services Location Index. The ranking was based on Ghana's ability to handle businesses under three main criteria: people skills and availability, financial attractiveness and business environment.

Furthermore, GIPC [18] asserted that Internet usage has caught up rapidly with Ghanaians over the last six to ten years. Internet growth has proliferated particularly in the private sector, which has made the internet become a very

important tool for business. GIPC [18] through a source from National communication Authority (NCA), Ghana provided a list of current communication service providers in Ghana. This is depicted in Table 1.

Additionally, between January-March 2013, the National Communication Authority (NCA) [19], [20] released penetration rates and subscription trends of mobile telecom voice and data in Ghana. These penetration rates are respectively shown in Table 2 and Table 3. These statistics show that in Ghana, current mobile voice and data subscriptions as well as penetrations are quite high and improve monthly most of the time. With respect to voice and data usage of mobile phones/devices, such statistics and scenarios have paved the way for mobile learning and ICT in education in Ghana.

## V. CONCLUSION AND RECOMMENDATION

Through relevant literature, this paper presented a perspective of how Polytechnics in Ghana can use ICT as a strategy to enhance their education. Using the 2003 Ghana ICT4AD Policy, the paper generally discussed factors Polytechnics should consider for successful ICT4E implementation. The paper further provided details about two frameworks in which Polytechnics in Ghana can consider and adopt as implementation procedures/strategies for ICT in education. The proposed frameworks were further discussed into details to ascertain which fundamental aspects Polytechnics in Ghana should consider for successful ICT4E implementation. This paper therefore recommends that Polytechnics in Ghana, should consider and adopt the proposed frameworks in conjunction with the Ghana ICT4AD policy, so that they can implement successful ICT4E in their institutions. Furthermore, as a future work, this paper recommends that continuous research involving both qualitative and quantitative research methodologies, should be conducted to determine the reality and current ICT state-of-the-art of Polytechnics in Ghana, in order to ascertain the actual problem(s) hindering ICT4E implementation. Correspondingly, such problems will need to be further examined and solved before ICT4E implementation.

## REFERENCES

- [1]. X. Muianga, H. Hansson, A. Nilsson, Avelino Mondlane, I. Mutimucuo and A. Guambe, "ICT in Education in Africa - Myth or Reality: A Case Study of Mozambican Higher Education Institutions," *The African J. of Inform. Syst.*, Vol. 5, Issue 3, Article 5, 2013.
- [2]. ICT in School Education (Primary and Secondary), Information and Communication Technology for Education in India and South Asia. *InfoDev, Pricewater House Coopers*, 2010,
- [3]. Retrieved July 08, 2013 from <http://www.infodev.org/en/Document.1016.pdf>
- [4]. Accra Polytechnic, Ghana, Retrived July 07, 2013 from [www.apoly.edu.gh](http://www.apoly.edu.gh)
- [5]. The 2003 Ghana ICT for Accelerated Development (ICT4AD) Policy, Retrieved July 01, 2013 from [http://img.modernghana.com/images/content/report\\_content/IC TAD.pdf](http://img.modernghana.com/images/content/report_content/IC TAD.pdf)

- [6]. S. Uvalic-Trumbic, "UNESCO's Role in the Development of Higher Education in a Globalized World," *Int. Encyclopedia of Education*, Vol. 4, Eds P. Peterson, E. Baker and B. McGaw, Elsevier, Oxford, pp. 597-602, 2010.
- [7]. Towards Knowledge Societies, *UNESCO World Report*, Paris, 2005, France,
- [8]. Retrieved August 05, 2013 from <http://unesdoc.unesco.org/images/0014/001418/141843e.pdf>
- [9]. G. M. Alam, "The Role of Science and Technology Education at Network Age Population for Sustainable Development of Bangladesh Through Human Resource Advancement," *Scientific Research and Essay*, Vol. 4, No. 11, pp. 1260-1270, 2009.
- [10]. C. Buabeng-Andoh, "Factors Influencing Teachers' Adoption and Integration of Information and Communication Technology into Teaching: A Review of the Literature," *International Journal of Education and Development Using ICT*, Vol. 8, Issue 1, pp. 136-155, 2012.
- [11]. S. Mumtaz, "Factors Affecting Teachers' use of Information and Communications Technology: A Review of the Literature", *Journal of Information Technology for Teacher Education*, Vol. 9, No. 3, pp. 319-34, 2000.
- [12]. R. Nachmias, D. Mioduser, A. Cohen, D. Tubin, and A. Forkosh-Baruch, "Factors Involved in the Implementation of Pedagogical Innovations Using Technology," *Education & Information Technologies*, Vol. 9, No. 3, pp. 291-308, 2004.
- [13]. B. Hoffman, "What Drives Successful Technology Planning?," *Journal of Information Technology for Instructor Education*, 5(1/2), pp. 43-55, 2001.
- [14]. T. Plomp, R. E. Anderson, N. Law and A. Quale (Eds.) "Cross-national Information and Communication Technology: Policies and Practices in Education". *Charlotte, N.C.: Information Age Publishing*, 2009.
- [15]. N.Y. Asabere and A. M. Ahmed, "Towards Enhancing Quality in Education through Information and Communication Technologies (ICTs) in Higher Educational Institutions (HEIs)", *International Journal of Computer Applications*, Vol. 62, No. 8, pp. 10-18, 2013.
- [16]. C. T. Norris, J. Sullivan, Poirot and E. Soloway "No Access, No Use, No Impact: Snapshot Surveys of Educational Technology in K-12," *Journal of Research on Technology in Education*, Vol. 36, No. 1, pp. 15-27, 2003.
- [17]. R. B. Kozma, "Counterpoint Theory of Learning With Media," In R. E. Clark (Ed.), *Learning From Media: Arguments, Analysis, and Evidence*, Information Age Pub Incorporated, Vol. 1, pp. 137-178, 2001.
- [18]. K. Mangesi, "Survey of ICT and Education in Africa: *Ghana Country Report*", 2007.
- [19]. Ghana at a glance - Centre for Educational Technology, Retrieved July 05, 2013 from <http://www.cet.uct.ac.za/files/file/ghana.pdf>
- [20]. Infrastructure – ICT, Ghana Investment Promotion Centre (GIPC), Retrieved August 02, 2013 from <http://www.gipcghana.com/invest-in-ghana/why-ghana/infrastructure/ict-infrastructure.html>
- [21]. National Communication Authority (NCA), Ghana – Mobile Telecom Voice Penetration Rates and Subscription Trends, Jan.-March 2013,
- [22]. Retrieved July 22, 2013 from [http://www.nca.org.gh/downloads/Telecom\\_Voice\\_Subscription\\_March\\_2013\\_web\\_version.pdf](http://www.nca.org.gh/downloads/Telecom_Voice_Subscription_March_2013_web_version.pdf)
- [23]. National Communication Authority (NCA), Ghana – Mobile Telecom Data Penetration Rates and Subscription Trends, Jan.-March 2013,
- [24]. Retrieved July 22, 2013 from [http://www.nca.org.gh/downloads/Telecom\\_Data\\_Subscription\\_March\\_2013\\_web\\_version.pdf](http://www.nca.org.gh/downloads/Telecom_Data_Subscription_March_2013_web_version.pdf)



**Nana Yaw Asabere** received his BSc in Computer Science from Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana in 2004 and MSc in ICT from Aalborg University, Denmark in 2010. He has nine (9) years of teaching/lecturing experience at the tertiary level of education in Ghana and is currently on Study Leave pursuing his PhD in Computer Science at School of Software, Dalian University of Technology, Dalian, P.R. China. Nana Yaw has a number of publications to his credits in International Journals and his research interests include: Artificial Intelligence (AI), Software Engineering, Expert Systems, Mobile Learning, E-learning, ICT in Education, ICT for Development, Information Systems, Multimedia, Recommender Systems, Social Computing, Wireless/Data/Mobile Communication and Computing Technologies.