



African Virtual University

Applied Computer Science: CSI1101

ICT FOR DEVELOPMENT

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Foreword

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This module was developed as part of a diploma and degree program in Applied Computer Science, in collaboration with 18 African partner institutions from 16 countries. A total of 156 modules were developed or translated to ensure availability in English, French and Portuguese. These modules have also been made available as open education resources (OER) on oer.avu.org.

On behalf of the African Virtual University and our patron, our partner institutions, the African Development Bank, I invite you to use this module in your institution, for your own education, to share it as widely as possible and to participate actively in the AVU communities of practice of your interest. We are committed to be on the frontline of developing and sharing Open Educational Resources.

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Table of Contents

Foreword	2
Production Credits	3
Copyright Notice	4
Supported By	4
Course Overview	10
Welcome to ICT for Development Basics	10
Prerequisites	10
Materials	10
Course Goals	10
Units	11
Assessment	12
Schedule	13
Readings and Other Resources	14
Unit 0. Pre-Assessment	16
Unit Introduction	16
Unit Objectives	16
Key Terms	16
Grading Scheme	17
Answers	17
Assessment	17
Unit 1. ICT for Development Basics	18
Unit Introduction	18
Unit Objectives	18
Key Terms	18
Learning Activities	19
Activity 1 - Application Areas of ICT in Context	19
Introduction	19

Assessment	20
Assessment	22
Assessment	24
Unit Summary	24
Assessment	25
Instructions	25
Grading Scheme	26
Answers	26
Unit Readings and Other Resources	26
Unit 2. ICT and Governance	27
Unit Introduction.	27
Unit Objectives	27
Key Terms	27
Learning Activities	28
Activity 1 - The Good Governance Constructs in Global Context	28
Introduction	28
Activity Details.	28
Assessment	31
Assessment	32
Activity 2 - Characteristics of Governance in African	32
Introduction	32
Activity 3 - The Digital/Electronic Transformation of Government	33
Introduction	33
Stage Model for eGovernment Implementations	37
Principles and Frameworks of eGovernance	38
Assessment	40
Unit Summary	40
Grading Scheme	41
Answers	41
Unit Assessment	41

Instructions	41
Unit Readings and Other Resources	42
Unit 3. ICT and Agriculture	43
Unit Introduction.	43
Unit Objectives	43
Key Terms	43
Learning Activities	44
Activity 1 - Application of ICT in Agriculture	44
Introduction	44
Activity Details.	44
The Nature of Agriculture in Africa	44
ICT and Agricultural Development	46
Key Drivers of ICT in Agriculture	47
ICT in Agricultural Knowledge Management	51
Assessment	52
Activity 2 - Towards Universal Access to ICT in Rural Areas	53
Assessment	57
Activity 3 - The Driving Factors to Universal Access to ICT	58
Introduction	58
Telecommunication Regulatory Frameworks and Policy Challenges	58
Trends and Issues in Making ICT Affordable in Rural Areas	59
Assessment	65
Activity 4 - ICT Powered Agricultural Development	66
Introduction	66
ICT Tools for Agricultural Development	68
Case Studies/Best Practices in eAgriculture	79
Assessment	85
Unit Summary	85
Unit Assessment	86
Instructions	86

Grading Scheme	87
Answers	87
Unit Readings and Other Resources	88
Unit 4. ICT and Healthcare	89
Unit Introduction.	89
Unit Objectives	89
Key Terms	89
Learning Activities	90
Activity 1 - ICT and Healthcare in Context	90
Introduction	90
Activity Details.	91
Assessment	92
Activity 2 - Health Information Systems	93
Introduction	93
Activity 3 - Digital Medical Records and the Application of ICT for Clinical Decision Support Systems and Remote Diagnosis.	95
Introduction	95
Assessment	95
Assessment	109
Unit Summary	109
Unit Assessment	110
Instructions	110
Grading Scheme	110
Answers	110
Unit Readings and Other Resources	111
Unit 5. ICT and Education	112
Unit Introduction.	112
Unit Objectives	112
Key Terms	112
Learning Activities	113

Activity 1 - Harnessing the Potential of ICT in Education	113
Introduction	113
Assessment	118
Activity 2 - ICT the Vehicle for Opening up Educational Resources	119
Introduction	119
Assessment	124
Activity 3 - MOOCs, Creative Commons, ICT-Powered Emerging Trends in	
Education	125
Introduction	125
Assessment	136
Unit Summary	136
Grading Scheme	137
Answers	137
Unit Assessment	137
Instructions	137
Unit Readings and Other Resources	138
Module Summary	139

Course Overview

Welcome to ICT for Development Basics

This course introduces learners to the application of ICT for development programmes. It will introduce learners to the debates and practices surrounding the uses of Information and Communication Technologies (ICT) in both the Global South and Global North. The module covers several issues about the potential and practical use of ICT for solving societal / countries challenges. It gives an account of the impact ICT can have in the base of the pyramid population. It is more specifically designed to equip learners the necessary skills that would enable them to harness the potential benefits of ICT on governance, education, agriculture and healthcare.

Prerequisites

Learners are expected to have taken several Computer Science courses such as Programming Basics, Advanced Programming, Data Communication and Computer Networks, and Mobile Computing and Mobile Networks.

Materials

The materials required to complete this course are:

- Besides the Module authored for the course, students are advised to refer to or use ICT4D e-books available in the various digital libraries such as OECD iLibrary.
- http://www.oecd-ilibrary.org/development/icts-for-development_9789264077409-en

Course Goals

Upon completion of this course the learner should be able to:

- Analyse societal challenges that need addressing via the intervention of ICT tools.
- Describe the process of socio-economic development and the role of information and of ICTs in the development process.
- Choose appropriate technological tools to solve community or society challenges so as to enhance access to healthcare, governance, education, agriculture and related services.
- Design ICT4D projects and see through to sustainable delivery of development goals.
- Design or customize innovative ICT application.

Units

Unit 0: Pre-Assessment

In this unit, a diagnostic test to assess learners grasp of preliminary notions in the ICT4D domain are presented as check list.

Unit 1: ICT for Development Basics

This unit provides a context for the ICT4D course by discussing some of the fundamental concepts that learners need to master in order to use ICT for developmental challenges of our time.

Unit 2: ICT and Governance

Many governments across the world are moving towards the use of Information Communication Technologies (ICTs) to allow citizens to access information and services. This unit introduces learners to the various e-government notions as well as best practices in the domain.

Unit 3: ICT and Agriculture

Increasing the efficiency, productivity and sustainability of farms is an area where ICT can make significant contribution. This unit introduces learners to ICT-powered agriculture which essentially means the enhancement of agricultural and rural development through improved information and communication processes.

Unit 4: ICT and Healthcare

Increasing the efficiency, effectiveness and sustainability of healthcare services or initiatives thereby improving the health and wellbeing of society is an area where ICT is making significant differences. This unit introduces learners to ICT-powered healthcare which essentially means the enhancement of healthcare delivery via the use of ICT.

Unit 1: ICT and Education

Increasing the efficiency, effectiveness, quality and universal accessibility of education is an area currently ICT is making significant differences. This unit introduces learners to ICT-powered education which essentially means the delivery of education via the use of ICT.

Assessment

Formative assessments, used to check learner progress, are included in each unit.

Summative assessments, such as final tests and assignments, are provided at the end of each module and cover knowledge and skills from the entire module.

Summative assessments are administered at the discretion of the institution offering the course. The suggested assessment plan is as follows:

1	Quizzes- after the completion of each unit students are required to take a quiz.	Each quiz weighs 5%, total 25%
2	Project- students in group(group composition must not exceed 3) to develop a software system(or an ICT-based solution) on identified developmental challenges in one of the sectors(Governance, Agriculture, Education and Health) that need ICT intervention.	45%
3	Final Exam	30%

Schedule

Unit	Activities	Estimated time
Unit 0: Pre-assessment	Performing the diagnostic test prepared to remind learners notions assumed to be known in advance	1
Unit 1: ICT for Development Basics	1.1 Application Areas of ICT in Context.	3
	1.2 The Term Development in Context	5
	1.3 Ingredients for Fostering the Potential of ICT	6
Unit 2: ICT and Governance	2.1 Learning Activity 2.1 The Good Governance Constructs in Global Context	9
	2.2 Characteristics of Governance in African	5
	2.3 The Digital/Electronic Transformation of Government	11
Unit 3: ICT and Agriculture	3.1 Application of ICT in Agriculture	4
	3.2 Towards Universal Access to ICT in Rural Areas	8
	3.3 The Driving Factors to Universal Access to ICT	9
	3.4 ICT Powered Agricultural Development	9
Unit 4: ICT and Healthcare	4.1 ICT and Healthcare in Context	8
	4.2 Health Information Systems	8
	4.3 Digital Medical Records and the Application of ICT for Clinical Decision Support Systems and Remote Diagnosis	9
Unit 5: ICT and Education	5.1 Harnessing the Potential of ICT in Education	8
	5.2 ICT the Vehicle for Opening Up Educational Resources	8
	5.3 MOOCs, Creative Commons, ICT-Powered Emerging Trends in Education	9

Readings and Other Resources

Unit 1

Required readings and other resources:

- E-development : from excitement to effectiveness by Robert Schware.
- ICTs and development in India : perspectives on the rural network society by T.T. Sreekumar, ISBN: 1843318431 Publication Date: 2011.

Optional readings and other resources:

- The readings below are optional for those who have access to the required resources mentioned above.
- Encyclopedia of developing regional communities with information and communication technology by / Stewart Marshall, Wal Taylor, and Xinghuo Yu, editors ISBN: 1591405750.
- Connecting ICTs to Development: The IDRC Experience, <http://www.idrc.ca/EN/Resources/Publications/Collections/ICT4D/Pages/default.aspx>, Date accessed- January 2016.

Unit 2

Required readings and other resources:

- E-Governance and Social Inclusion: Concepts and Cases by Scott Baum (Griffith University, Australia) and Arun Mahizhnan (National University of Singapore, Singapore)
- E-Governance: Concepts and Cases Studies, C.S.R. Prabhu, Prentice Hall of India, 2004.
- ICT and Local Governance: A View from the South, Susana Finquelievich (University of Buenos Aires, Argentina).
- e-governance for Citizen Empowerment, http://www.nic.in/sites/upload_files/nichome/files/documents/e-Governance_Book_2012.pdf .

Optional readings and other resources:

- <http://www.idrc.ca/EN/Themes/Governance/Pages/e-books.aspx>
- Reading the resources below is optional as they are supplementary to the resources mentioned above.
- E-government for good governance in developing countries Empirical Evidence from the e-Fez Project
- Local governance and ICTs in Africa
- Case Studies and Guidelines for Implementation and Evaluation

Unit 3

Required readings and other resources:

- "ICT in Agriculture: Perspectives of Technological Innovation", E. Gelb, A. Offer, The Hebrew University of Jerusalem Center for Agricultural Economic Research.
- E-Agriculture and Rural Development: Global Innovations and Future Prospects, Blessing Maumbe (Bindura University of Science Education, Zimbabwe) and Charalampos Z. Patrikakis (Technological Educational Institute of Piraeus, Greece).

Optional readings and other resources:

- Reading the resources below is optional as it is supplementary to the resources mentioned above.
- ICT for agriculture, rural development and environment - Where we are? Where we will go? By Tomas Mildorf, Karel Charvat jr.

Unit 4

Required readings and other resources:

- ICTs for Health and Wellbeing: Principles and Practice Published by OMICS Group International.
- ICTs and the Health Sector Towards Smarter Health and Wellness Models Published by OECD.
- Enabling Health and Healthcare through ICT Published by IOS Press

Optional readings and other resources:

- Reading the resources below is optional as it is supplementary to the resources mentioned above.
- Roadmaps for Future ICT Use in the Health Sector Maria Borges Tiago (University of the Azores, Portugal) and Flavio Tiago (University of the Azores, Portugal).

Unit 5

Required readings and other resources:

- ICT: Changing Education by Chris Abbott.
- ICT in Education in Global Context, Comparative Reports of Innovations in K-12 Education, Huang, Ronghuai, Kinshuk, Price, Jon K.
- Rethinking Education with ICT: New Directions for Effective Practices by Eva Dakich.

Unit 0. Pre-Assessment

Unit Introduction

This unit reminds learners the most important notions that they are assumed to have known. In other words it is also about carrying out a diagnostic test in order to be able remind the basic knowledge required by the learner. Thus, before delving into the main topics of the module, areas that a learner is expected to cover are presented in this unit to serve as a check list.

Unit Objectives

Upon completion of this unit you should be able to:

- Distinguish terminologies associated to ICT for development;
- Recognize the developmental challenges of countries in the global south,
- Recognize the level of knowledge and technical skills required to tackle developmental challenges using ICT.
- Recognize the need to design affordable ICT solutions primarily based on open source tools.

Key Terms

Underserved Community: refers to communities with inadequate services to healthcare, education, etc.

Open Source Software: software whose source code is available for modification or enhancement by anyone.

TV White Space: refers to the unused broadcasting frequencies in the wireless spectrum.

Assessment

1. Discuss the pros and cons of open source versus proprietary software.
2. Discuss the benefits of mobile technologies for underserved communities.
3. Discuss how ICT can help to improve healthcare delivery in underserved communities.
4. Discuss how ICT can help to improve citizens to government interaction.
5. Discuss how ICT can help to achieve the good governance constructs such as transparency, accountability, efficiency, effectiveness, and others.
6. What does ICT4D mean?
7. What does TV white space mean and how can it be used for connecting underserved communities to the Internet?

Grading Scheme

The questions are meant to assess learners background on ICT tools that are critically required for working on ICT for development projects or case studies. The assessment questions weight need not to exceed 7% and learners who carried out the learning activities successfully and answered the assessment questions correctly can earn 7 points or marks.

Answers

1. Meaningful justification based on cost, technical feasibility and other related factors.
2. Developing countries have challenges in terms of deploying a robust telecommunication mainly because of lack of budget and as a workaround solution mobile networks can be considered
3. ICT enables remote diagnosis, telemedicine and the like
4. Making government services online enhances government to citizens interactions, it enhances citizens participation in government decision making.
5. There are several case studies where ICT has proven to be an important tool in achieving the good governance constructs, just mentioning considering one example and explaining what improvements have been brought is enough.
6. The use of ICT for tackling developmental challenges.
7. TV white spaces are spectrums that are not used by TV channels, they can be used in rural areas to provide Internet connectivity.

Unit 1. ICT for Development Basics

Unit Introduction

This unit provides you a context for the ICT4D course by discussing some of the fundamental concepts that learners need to master in order to use ICT for developmental challenges of our time.

Unit Objectives

Upon completion of this unit you should be able to:

- Distinguish notions such as Development versus Under-development, Development and Aid and the North-South divide;
- Analyse and synthesize developmental challenges of our time;
- Analyse how ICT knowledge and skills need to be aligned to solve developmental challenges; and
- Appreciate as to how ICT tools can serve as a vehicle on solving developmental challenges.

Key Terms

Global South: refers to the countries of the rest of the world, most of which are located in the Southern Hemisphere. It includes both countries with medium human development (88 countries with an HDI less than .8 and greater than .5) and low human development (32 countries with an HDI of less than .5).

Global North: refers to the United States, Canada, Western Europe and developed parts of East Asia.

Learning Activities

Activity 1 - Application Areas of ICT in Context

Introduction

Before jumping into the core issues of the information technology for development (ICT4D) module, which you will be doing in subsequent units, in this unit, basic topics that learners are required to have mastered in order to be able to get the most of the ICT4D module are discussed. Understanding the requisite topics such as the potential benefits of ICT tools, Development and Underdevelopment, Development and Aid, the North-South divide will enable you to have a clear understanding of developmental challenges that society of our time faces and, subsequently broadening your view of the potential uses of ICT with respect to the provision of technology-mediated solutions to the challenges.

Understanding ICT- What is ICT?

These days it is common to see the letters ICT in any initiatives or endeavor, though it cannot be said that there is a universal definition of ICT, there are however more commonalities than differences to existing definitions. Differences in existing definitions of ICT are partly attributed to the reason that concepts, methods and application in ICT are under continuous evolution in almost on a daily basis- technology advancements occur in unprecedented pace and the definition coined out at one moment as a result gets obsolete in some respect quickly.

According to [1], ICT is defined as follows "ICT (Information and Communication Technologies) is an umbrella term that includes any communication device or application encompassing: radio, television, cellular phones, smart phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning."

By merely having a closer look at the three words that constitute the terms ICT (Information Communication and Technologies), in a simplified view of it, ICT can be associated with all uses of digital technology that already exist to help individuals, businesses and organizations use information products. However, there is more to the term ICT than the separate words that constitute it; it is a very loaded term and encapsulates several things beyond access to and delivery of information. It provides people a vast array of communication capabilities. The term ICT encompasses:

- any medium to record information (whether paper, pen, magnetic disk/ tape, optical disks - CD/DVD, flash memory etc.);
- conventional technologies for broadcasting information - radio, television;; any technology for communicating through voice and sound or images- microphone, camera, loudspeaker, and telephone;

and modern technologies for communicating or exchanging information such as:

- mobile technologies,
- email,
- two-way instant messaging,
- chat rooms,
- blogs,
- personal web pages,
- social networking.

Reflective Activities:

Conduct an inventory of developmental challenges that surfaced in the global-south or developing countries, prioritize them and distinguish those that can be tackled using ICT with those that cannot be solved with ICT intervention with a valid justification (**hint:** focus on problems associated to healthcare delivery, education, agriculture and governance.)

Compare and contrast adoption versus innovation of ICT solutions

Which Model(adoption or innovation) developing countries need to use to address developmental challenges using ICT.

Conclusion

ICT has become an indispensable tool to solve developmental challenges of countries. To harness ICT for the socio-economic progression of countries innovative as well as adaptive use of ICT has paramount significance. ICT has immense power in transforming as well as hastening the socio-economic progression of countries. Developing countries faces numerous challenges such as lack of universal access to healthcare and education, etc. In this unit you are required to explore developmental challenges of developing countries and how ICT can be used to tackle them. In this activity you have been introduced to the various areas where ICT can be effectively used.

Assessment

1. Feasibility and practicality of developing ICT tools for the challenges identified, the learner grasp of the application of ICT on developmental challenges, etc.

Activity 2 - The Term Development in Context

Introduction

Understanding Development- What is Development or Under-Development?

In the literature there have been several attempts to define the word “Development”. According to Chambers (1997), development is defined as “Good Change”, however this definition is not as straightforward as it sounds because of the subjectivity associated to the use of the word “good” in that it is difficult to rate which change is good and, who should make the rating.

According to the World Bank, as many as half of the world’s six billion inhabitants live on the equivalent of less than \$2 per day, and about one-fourth of the world lives on the equivalent of less than \$1.25 per day (Chen & Ravallion, 2008). Meanwhile, people in the 20 richest countries earn, on average, 39 times more than people living in the poorest 20 states (Milanovic, 2007). However in recent years the extent of world poverty is in a state of decline and the percentage of people living on less than \$1 per day was halved, decreasing from 52 percent to 26 percent during this period (Chen & Ravallion, 2008).

These current realities highlight both the problems and the progress associated with the process of “development.” On one hand, development has resulted in serious inequities between states, whereby large numbers of the world’s inhabitants are mired in poverty, especially in Africa, while inhabitants of the world’s richest countries live in both relative and absolute luxury. And yet, due to development trends, populations in poor countries are becoming wealthier over time—a process linked to globalization because countries in the developing world can raise their standards of living by integrating with highly developed states[2].

According to the World Bank and other stakeholders, the term “development” therefore encompasses the need and the means by which to provide better lives for people in poor countries. It includes not only economic growth, although that is crucial, but also human development—providing for health, nutrition, education, and a clean environment. One of the reasons that development is gaining so much attention is because of the stark divide between poor(developing) and rich(developed) countries. The United Nations Development Program (UNDP) rates countries’ development annually according to its Human Development Index (HDI), which includes measurements of citizens’ access to healthcare, educational attainment, and standards of living, among other factors.

Reflective Activities:

List the divides or gaps between the global south and north and describe how ICT is/ can be used to narrow the gaps. Leapfrogging is a term frequently used to describe the potential of countries to quickly transform their social, political, economic progressing with the use of ICT. What other factors need to be addressed for countries to harness the power of ICT and make a jump start in their social, political and economic status.

Conclusion

The south and north divide refers to differences between the rich and poor countries of the world. In this activity you are required to identify as many divides or gaps between the south and north countries of the world and propose how ICT can be used to narrow the gaps.

Developing countries can harness the potential of ICT in the various sectors such as education, healthcare, agriculture and governance. It would be good for learners to identify those gaps and understand their nature.

Assessment

1. Completeness of the gaps identified, understanding the gaps impact on ICT use.

Activity 3 - The Term Development in Context

Introduction

The North-South Divide- What are Global South and Global North?

The North–South divide is broadly considered a socio-economic and political divide, with North America, Western Europe and some parts of Asia constituting the Global North and Africa, Latin America, some parts of Asia and the Middle East constituting the Global South [3]. In economic terms, the North, with one quarter of the world population, controls four fifths of the world income. 90% of the manufacturing industries are owned by and located in the North. Inversely, the South, with three quarters of the world populations has access to one fifth of the world income. Its role in the economy mainly is a supplier of raw material for the North.

The north–south divide has more recently been named the development continuum gap. This places greater emphasis on closing the evident gap between rich (more economically developed) and poor (less economically developed) countries. The Human Development Index (HDI) has been the most widely used metric to measure on which side of the gap a country is located . The nearer the index gets to 1.0, the greater is the country's level.

of development and the further the country is on its development pathway (closer towards being well developed).

http://en.wikipedia.org/wiki/Human_Development_Index

Development and Aid

Development is not the same as Aid. Aid is the transfer of resources from one place to another. By its nature, it goes in one direction only, often from the North to the South. For example, when there is a natural disaster or a war, people are in need of immediate basic resources such as food, water and medical care. Aid may be sent in the form of money, equipment, medical staff, food, clothing or similar. However, aid is for immediate relief, but doesn't often contribute to long term rebuilding or recovery. On a smaller scale, money sent by diasporas to their families in countries of origin to cover costs of living may be considered aid [4,5]. Development on the other hand is more complex, as explained above.

What can ICT do to Foster Development?

The increasing international interest in the potential of ICT as a tool for fostering sustainable human development has been reflected in a series of activities, and accelerated by a number of events.

Over the years, ICT has brought on enormous socio-economic progression of nations, the view that ICT is an enabler of socio-economic progression is deepening in almost in every sector. ICT enables economic growth by broadening the reach of technologies such as high-speed Internet, mobile broadband, and computing; expanding these technologies itself creates growth, and the fact that technologies make it easier for people to interact and make workers more productive creates additional benefits. Beyond economic benefits, the ICT industry is uniquely positioned to help build a more socially sustainable future [6].

Governments have also realized that ICT can offer social benefits, so they have launched several programs to improve the level of health, education, and government services they offer to their citizens. For instance, ICT is making an important contribution to health delivery: doctors can directly access their patients' medical records from anywhere.

Creating these economic and social benefits will require not only large investments and commitment from different stakeholders but also changes to existing regulatory frameworks, compromises between governments and industries, and strong public engagement.

Reflective Activity:

Identify the key or enabling factors that can shape the use of ICT for development such as the use of ICT in education, healthcare, governance, agriculture, etc.

Develop/sketch a paradigm or functional model that depicts the developmental challenges and the various actors that need to be involved with ICT taking the center stage.

Conclusion

To harness the potential of ICT on fostering development, understanding of the key factors that affects ICT use both positively and negative has paramount significance. In this activity you are required to identify those factors which can positively contribute on fostering developments through the intervention of ICT.

Addressing developmental challenges among other things need to be a collaborative effort. The various actors (the government, non-government, civil-society, etc) need to collaborate to bring in the desired effects. It would be good for learners to identify the key or enabling factors that promote the use of ICT for developmental challenges.

Assessment

1. Completeness of the key or enabling factors identified, understanding the factors impact on ICT interventions to mitigate developmental challenges.

Unit Summary

In this unit preliminary notions that learners need to master in order to make their learning experience of the ICT4D module more meaningful have been covered. Terms such as ICT, development, the North-South divide, Aid and in more specific terms the developmental challenges that need ICT powered interventions or solutions have been discussed. In subsequent units you will be introduced to specific developmental challenges as well as ICT's role in ameliorating interventions or solutions to challenges in a sector by sector basis will be presented.

Assessment

Check your understanding!

Instructions

A solid understanding of the following items is a necessity, in case of doubts learners

are advised to read the notions by going back to the specific sections as well as the reference materials recommended.

- a. Understanding ICT and the various elements
 - b. Understanding development in the context of ICT intervention
 - c. Development versus Aid.
1. What can ICT do to foster development?
 2. Discuss on how can ICT enable citizens to get government services anytime and anywhere?
 3. Discuss on how can ICT enable to address developmental challenges such as universal access to education?
 4. Discuss on how can ICT enable to address developmental challenges such as universal healthcare?
 5. Discuss on how can ICT enable to address developmental challenges such as increased productivity in agriculture or enhanced agricultural supply chain?

Grading Scheme

The course facilitator is required to prepare subjective questions with respect to what is covered in this unit. The above questions are included as sample to aid in course module facilitators on how to prepare unit assessment questions, and as suggested in the assessment plan this unit assessment weight should not exceed 5%.

Answers

1. Making government services available online, making services accessible via ICT devices such as computers and mobiles. Giving examples of such uses of ICT is required.
2. Through the use of eLearning tools or platforms countries or governments can achieve their goal of making education accessible for all. Giving examples of such uses of ICT is required.
3. Through the use of eHealth systems countries or governments can achieve their goal of making education accessible for all. Giving examples of such uses of ICT is required.
4. e-Agriculture systems can enhance productivity in agriculture or agricultural supply chain. Giving examples of such uses of ICT is required.

Unit Readings and Other Resources

- GI Global, <http://www.igi-global.com/dictionary/information-and-communication-technology-ict/14316>, Date accessed- April, 2015.
- Globalization 101, A Project of SUNY LEVIN Institute, <http://www.globalization101.org/introduction-what-is-development-2/>, Date accessed- April 2015.
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Unit 2. ICT and Governance

Unit Introduction

Many governments across the world are moving towards the use of information and communication technologies (ICTs) to allow citizens to access information and services. This unit introduces you to e-government. You will look at the scope of e-government, the key elements of e-governance, principles and frameworks of e-governance in depth.

Unit Objectives

Upon completion of this unit you should be able to:

- Analyse the role of ICT in governance;
- Explain constructs of good governance, key elements as well as the types of interactions of e-government;
- Examine the different types of e-government interactions- their transformational capabilities of governance and associated benefits;
- Demonstrate different ways in which ICT can be better integrated in governance systems; and
- Develop the skills to critically evaluate government web sites and e-services against best practice principles and standards.

Key Terms

Back Office: the term Back-Office covers the processes and workflows of organisations which, unlike the front-office, are run in the internal part of an organisation and which are mostly invisible to the customer or citizen.

Front Office: it is the point where customers can directly get in touch with the office.

Learning Activities

Activity 1 - The Good Governance Constructs in Global Context

Introduction

The Internet is continuously transforming the way businesses are transacted and government interacts with citizens and businesses. While businesses were the first to adopt and use information technologies, from personal computers to advanced electronic or digital data interchanges, consumers have followed quickly, especially in the adoption and use of the Internet. Information and communication technology and especially the Internet is a transformative tool that can make governments more open and transparent. It empowers citizens in that it can be used by citizens to watch their governments. Governments are under more pressure than ever because of globalization, fiscal demands, evolving societies and high citizen expectations. They are expected to deal with a lot of issues of social, economic and political nature effectively as well as efficiently- being responsive to social change, address public concerns, manage public funds efficiently, etc is gradually becoming a necessity for governments to succeed. Over the last couple of decades, citizens' expectation on governments has grown to a new high because of the widespread use of the Internet. ICT tools especially the Internet can make governments more relevant to citizens by increasing participation and involvement in decision making. It can help to restore ownership to strengthen the belief that the government is of the people, it can also help to increase accountability by streamlining all administrative steps making them easy to follow and introduce transparency in government decision making processes.

Activity Details

What is Governance?

The concept of "governance" is as old as human civilization. It can be used in several areas or contexts in that there are many areas where governance has been an integral part of many forms of organizational structures such as corporate governance, international governance, national governance and local governance. However, in spite of these differences in organizational structures, the definition of governance in the literature as well as online dictionaries more or less converges to the same expressions. For this module the definition given in [2] has been adopted. In its most abstract sense, governance is a theoretical concept referring to the actions and processes by which stable practices and organizations arise and persist. These actions and processes may operate in formal and informal organizations of any size; and they may function for any purpose, good or evil, for profit or not. Conceiving of governance in this way, one can apply the concept to states, to corporations, to non-profits, to NGOs, to partnerships and other associations, to project teams, and to any number of humans engaged in some purposeful activity.

The term governance should be distinguished from government in that a government is a formal body invested with the authority to make decisions in a given political system. In this case the governance process, which includes all the actors involved in influencing the decision-making process (such as lobbies, parties, medias), is centered on the relevant “governing body”. Whether the organization is a geopolitical entity (nation-state), a corporation (a business or organization incorporated as a legal entity), a socio-political entity (chiefdom, tribe, family, etc.), or an informal one, its governance is the way the rules, norms and actions are produced, sustained, regulated and held accountable. The degree of formality depends on the internal rules of a given organization[1,2].

a. Public Governance

Public governance is an interdisciplinary field of study centering on relationships of power between government authorities, civil society and the market, in a context of transformations in the ability of political communities to legitimately govern themselves and act effectively. These relationships can vary in nature, embodying relationships of authority (i.e., authority exerted by the State but also by the market through the enforcement of contractual arrangements) as well as relationships of influence and persuasion, coercion and manipulation [3].

It is useful to note the distinction between the concepts of governance and politics. Politics involves processes by which a group of people (perhaps with divergent opinions or interests) reach collective decisions generally regarded as binding on the group, and enforced as common policy. Governance, on the other hand, conveys the administrative and process-oriented elements of governing rather than its antagonistic ones.

In general terms, public governance occurs in three broad ways[2]:

Through networks involving public-private partnerships (PPP) or with the collaboration of community organizations.

Through the use of market mechanisms whereby market principles of competition serve to allocate resources while operating under government regulation.

Through top-down methods that primarily involve governments and the state bureaucracy.

b. Private Governance

Private governance is a type of governance which occurs when non-governmental entities take actions that achieve traditionally governmental ends. These ends include providing public goods. In other words, private governance occurs when non-governmental entities, including private organizations, dispute resolution organizations, environment protection organizations or other third party groups, make rules and/or standards which have a binding effect on the “quality of life and opportunities of the larger public.” Simply put, private—not public—entities are making public policy [4].

c. Global governance

Global governance is defined as “the complex of formal and informal institutions, mechanisms, relationships, and processes between and among states, markets, citizens and organizations, both inter- and non-governmental, through which collective interests on the global plane are articulated, right and obligations are established, and differences are mediated” [2]. In contrast to the traditional meaning of “governance”, the term “global governance” is used to denote the regulation of interdependent relations in the absence of an overarching political authority. The best example of this is the international system or relationships between independent states.

What is Good Governance

Good governance is defined as “the manner in which power is exercised in the management of a country’s economic and social resources for development” [5]. It requires all concerned to be clear about the functions of governance and their own roles and responsibilities and those of others, and to behave in ways that are consistent with those roles [6]. Being clear about one’s own role, and how it relates to that of others, increases the chance of performing the role well. Clarity about roles also helps all stakeholders to understand how the governance system works and who is accountable for what.

a. Constructs of Good Governance

Good governance is, among other things, participatory, transparent and accountable. It is also effective and equitable, and promotes the rule of law fairly. Good governance ensures that the voices of the poorest and the most vulnerable are heard in decision-making over the allocation of development resources, and that political, social and economic priorities are based on broad consensus among the three stakeholders the state, private sector and civil society. All three stakeholders are critical for sustaining human development: the state creates a conducive political and legal environment; the

private sector generates jobs and income; and civil society facilitates political and social interaction. With the advent of globalization and the integration of economies, the state’s task is also to find a balance between taking advantage of emerging market opportunities and providing a secure and stable social and economic environment domestically [7]. The following are constructs of good governance:

Participatory- all men and women should have a voice in decision-making, either directly or through legitimate intermediate institutions that represent their interests.

Transparency- it is built on the free flow of information. Processes, institutions and information are directly accessible to those concerned with them, and enough information is provided to understand and monitor them.

Accountability- decision- makers in government, the private sector and civil society organisations are accountable to the public, as well as to institutional stakeholders. This

accountability differs depending on the organisation and whether the decision is internal or external to an organization.

Rule of law- legal frameworks should be fair and enforced impartially, particularly the laws on human rights.

Responsive- institutions and processes try to serve all stakeholders.

Consensus oriented- Good governance mediates differing interests to reach a broad consensus on what is in the best interest of the group and, where possible, on policies and procedures.

Equity - all men and women have opportunities to improve or maintain their well-being.

Effective and efficient- Processes and institutions produce results that meet needs while making the best use of resources

Reflective Activity : Essay/Write-up

How do you see the status of good governance in developing countries compared to the developed ones? Is the global south- north divide reflected again?

Select a country of interest in Africa and assess how the country is faring with respect to the eight good governance constructs?

In what ways ICT tools can contribute or enhance the realization of the good governance constructs?

Conclusion

In recent years the notion of good governance has gained significant attention worldwide. Metrics have been identified to gauge countries standings in terms of how they are faring with the good governance constructs discussed above. Governance is a very sensitive issue across countries. The issue is even more serious in the global south. In this activity, you are introduced to the basic notions of good governance and the constructs that characterise a governance system. It would be good for learners to understand the scale and nature of governance issues or problems in order to be able design ICT-based solutions.

Assessment

1. Clarity and completeness of the essay or write up, learners ability to prepare the write up using owns word as opposed to copying and pasting from the referenced sources as they are.

Activity 2 - Characteristics of Governance in African

Introduction

The Nature of Governance in Africa

Improved governance remains central to African countries development as well as economic transformation. The demand for political participation and the involvement of the people in the choice of their leaders and decision-making which constitutes the critical hub of political democracy (Sorensen, 1993) are not a new phenomenon in Africa [8]. The anti-colonial project was constructed and legitimized on this basis. The crises which the continent is suffering from in many cases are linked to governance. In fact there is a view that the underlying African countries development problems are a crisis of good governance. African countries have a long way to go to achieve the constructs of good governance.

Reflective Activity: Essay/Write-up:

What are the characteristics of governance in Africa?

It is being said that ICT has a huge potential to transform the governance of Africa and to cater to the developmental needs of its people, what does this mean?

How can ICT catalyze developmental reforms and reduce corruptions in Africa?

Conclusion

Improved governance remains central to African countries development as well as economic transformation. It would be good for learners to understand the scale and nature of governance issues or problems in Africa in order to be able design ICT-based solutions to address the sector challenges.

Assessment

1. Clarity and completeness of the essay or write up, learners ability to prepare the write up using owns word as opposed to copying and pasting from the referenced sources as they are.

Activity 3 - The Digital/Electronic Transformation of Government

Introduction

e-Government

e-government is defined as the use of information and communication technologies (ICTs) to improve the activities of public sector organisations. In general terms, it can be defined as the use of information and communication technologies in government settings . In order to give you a better picture of how the range of ICT tools can be used in the governance domain, an attempt has been made to unpack the concept of e-government in terms of the range of services it encompasses in the form of the items described below.

e-government projects in relation to ICT tools therefore can be viewed or defined as:

- The provision of information to the public or to other civil and public service bodies through electronic means such as the web, mobile phone text messaging (SMS), data/file transfers;
- The provision of services to the public or to other civil and public service bodies through electronic means (in whole or in part) such as the web or SMS;
- The automation of services to customers by negating the need for customer involvement;
- The provision of high-quality directory-type information such as locations, availability, opening hours, contact information, services on offer at that location, etc. through electronic means;
- Central databases of information that are of wide/general interest across the civil and public service, e.g., identity; birth, marriage and death events; company events, etc.;
- Online precursors or triage processes that help customers determine their eligibility prior to undertaking a formal application for a service, as these can often be provided simply and at low cost while delivering considerable gain in terms of quality of customer service and administrative efficiency; and
- The provision of application forms that can be completed and stored online, but also use smart technologies to produce 2-D or 3-D barcodes which store the contents on the printed version of the form so that they can be automatically scanned and matched – particularly pertinent in cases where physical signatures are required on applications or additional supporting documentation must accompany the application.

e-Government cannot be seen as merely the application of ICT on governance, if and when necessary it requires improvements or streamlining in internal processes through changes to the risk approach taken, underpinning law or regulations, procedures, processes, forms, channels used, and job functions, that, in turn, improve information and service provision.

In the digital age, the work of government is being reshaped by two ineluctable trends [9]. The first is the movement away from centralised, vertical and hierarchical government machines towards polycentric networks of governance based upon horizontal interactions between diverse actors within complex, dynamic and multilayered societies.

Secondly, there has been the rapid growth of information and communication technologies which can transform the generation and delivery of public services, thereby reconfiguring relationships between government and citizens (G2C), governments and businesses (G2B) as well as within and between governments (G2G).

eGovernment has the potential to improve the performance of public institutions and make them more transparent and responsive; facilitate strategic connections in government by creating joined-up administrations in which users can access information and services via portals or 'one-stop-shops'; and empower civil-society organisations (CSOs) and citizens by making knowledge and other resources more directly accessible.

Types of Interactions in eGovernment

eGovernment facilitates interactions between different stakeholders in governance. These interactions may take either of the following forms :

G2C (Government to Citizens)- an interface is created between the government and citizens which enables the citizens to benefit from efficient delivery of a large range of public services. This expands the availability and accessibility of public services on the one hand and improves the quality of services on the other. It offers citizens flexibility and convenience with respect to the choice of:

- When to interact with the government (for instance 24 hours a day, 7 days a week),
- From where to interact with the government (for instance at service center, unattended kiosk or from one's home/workplace), and
- How to interact with the government (for instance through internet, fax, telephone, email, face-to-face, etc.) the primary purpose is to make government, citizen-friendly.

G2B (Government to Businesses)- in this interaction type e-governance tools are used to aid the business community (assumed to be providers of goods and services) to seamlessly interact with the government.

The objective is to cut short excessive and redundant regulations or rules considered to be bureaucratic, save time, reduce operational costs and to create a more transparent business environment when dealing with the government.

The G2B initiatives can be:

- transactional, such as in licensing, permits, procurement and revenue collection.
- promotional and facilitative, such as in trade, tourism and investment.
- These measures help to provide a friendly environment to businesses to enable them to perform more efficiently.

G2E (Government to Employees)-government is by far the biggest employer and like any organisation, it has to interact with its employees on a regular basis. This interaction is a two-way process between the organization and the employee which helps in fast and efficient service on one hand and increase satisfaction levels of employees on the other.

G2G (Government to Governments)- in this type of interaction, ICT is used to increase the flow of information and services within and between different entities of the government. This kind of interaction is only within the sphere of government and can be both horizontal and vertical.

Horizontal interaction means between different government agencies, as well as between different functional areas within an organization, and vertical interaction means between national, state and local government agencies, or different levels within an organization. The primary objective is to increase efficiency, performance and output of the government.

Key Elements of eGovernment

eGovernment incorporates four key elements that, when combined, create a unified process: eServices, eAdministration, eCitizens and eSociety.

eServices: is defined as the electronic delivery of government information, programs and services, often (but not exclusively) over the Internet. The term "service" implies the meeting of some public need and/or the system or operation by which people are provided with something they need.

This electronic version of service includes functions such as live chatting, web conferencing, video conferencing, supply chain management, customer relationship management, etc. Some eServices enable live meeting which makes possible employees to work together with colleagues, customers, and suppliers no matter where they are.

eAdministration- it is the form of public administration that uses ICT to carry out governance activities, with emphasis on the three aspects: relations with the citizen, internal functioning and relations with other local councils. It also refers to any of the available mechanisms which convert what in a traditional office are paper processes into electronic processes, with the goal being to create a paperless office. It is about the use of ICT tools in automating administrative functions, with the goal being to improve productivity and performance.

It can encompass both intra-office and inter-office communication for any organization. It helps to introduce total transparency and accountability leading to better eGovernance in an organization[10,11].

The following are principles of eAdministration:

Multi-channel- promoting services by offering them through all available channels to citizens.

Administrative publicity and transparency- making information on administrative procedures accessible and without cost.

Accessibility- guaranteeing that all citizens can access services and information through electronic devices.

Cooperation between public administrations- allowing for interaction between administrations or administrative units and providing combined services to citizens. Mutual recognition of electronic documents and identification and authentication systems.

Security- requiring that electronic provision of services has, at least, the same level of security as services that are not offered electronically. Security levels should allow an increase in electronic transactions with sectors that are particularly sensitive to this issue (professional workers, companies.).

Proportionality- only demanding the guarantees and security measures appropriate for the procedure being carried out. The citizen will not be asked to give more information than is strictly necessary.

Responsibility and quality- obeying procedures and rules on services that the public administrations offer through electronic devices. This may entail reconsidering local communication and information policies.

Technological neutrality- progressing in the use of open standards or those which are generally used by the public, avoiding being dependent on software tools with license costs in relations with the citizens.

eCitizens – sometimes also called as digital citizens refer to a person utilizing/using ICT in order to engage in society, politics, and government participation. Some also refer to it as “those who use the Internet regularly and effectively.” To qualify as a digital citizen, a person generally must have extensive skills, knowledge, and access of using the Internet through computers, mobile phones, and web-ready devices to interact with private and public organizations[11]. People who consider themselves as digital citizens often use IT extensively, creating blogs, using social networks, and participating in web journalism sites.

In developing countries the build-up of digital citizens is at its nascent stage. The majority of people living in developing countries have no access to modern ICT, and in these countries there have been limited efforts to use ICT to overcome developmental challenges such as corruption, conflict resolution and lack of good governance in general[12].

eSociety- it refers to the relationship or interaction between public agencies and institutions such as private sector companies, non-profit and community organizations and other public agencies. It can manifest in the following ways[13]:

Working better with business - improving the interaction between government and business. Which includes digitising regulation of, procurement from, and services to, business to improve quality, convenience and cost.

Developing communities - building the social and economic capacities and capital of local communities.

Building partnerships - creating organisational groupings to achieve economic and social objectives. The public sector is almost always one of the partners, though occasionally it acts only as a facilitator for others.

Stage Model for eGovernment Implementations

In literature there have been proposals to measure progresses for eGovernment initiatives. Hiller's (2001) five-stage model and American Society for Public Administration (ASPA's) five-stage model focus on a web-based public service; Deloitte's (2001) six-stage model is based on the customer service perspective; Layne & Lee's (2001) four-stage model and Moon's (2002) five-stage model are developed based on a general or an integrated perspective combining technical, organizational, and managerial feasibility. There are more commonalities than difference across the proposals. The ASPA's has proposed five-stage model or benchmarks [15] for quantifying progress of eGovernment, it consists of :

Stage 1: Emerging or Web presence- An official government online presence is established through a few independent official sites. Information is limited, basic and static.

Stage 2: Enhanced or Interaction- Government sites increase; information becomes more dynamic. Content and information is updated with greater regularity.

Stage 3: Interactive or Transaction- Users can download forms, e-mail officials, interact through the web and make appointments and requests.

Stage 4: Transactional or Transformational- Users can actually pay for services or conduct financial transactions online.

Stage 5: Seamless or Integration- Full integration of eServices across administrative boundaries. Total integration of e-functions and services across administrative and departmental boundaries.

Issues in eGovernment Project Implementations. Issues that surround eGovernment project are complex, the following are some of them;

- **Technical issues-** how are services to be made available online? Which services cannot be adapted to online delivery?
- **Cost-** all large-scale ICT enterprises cost a lot. Will the benefits of introducing e-government justify the expenditure?

- **Expertise**- large-scale ICT projects require a great deal of expertise to set them up, and a lot of expertise to keep them running. Is sufficient expertise available?
- **Management**- how do you manage an eGovernment project, both in the setting-up phase and the running phase?
- **User Interface**- the user interface is what the user sees (and in some cases hears) and interacts with. In an online environment where no one is available to help the user, how easy will it be to use government services?
- **Usage**- will people be interested to use online eGovernment systems?

Principles and Frameworks of eGovernance

Principles of eGovernance

Over the years there have been too many eGovernance initiatives implemented throughout the world and it would be critical to analyze those initiatives in order to be able to formulate the core principles essential for the success of eGovernance initiatives. The following are core principles of eGovernance:

Clarity of Purpose- There needs to be a clear understanding and appreciation of the purpose and objectives to be achieved through e-Governance.

Environment building- There is need to change the mind-set of all the stakeholders involved, i.e. politicians, government officials and civil society at large.

Integrating eGovernance to reforms in governance- e-Governance cannot be separated from governance as a whole. It needs to be seen as an integral part of the governance structure and processes.

eReadiness and Evolutionary Approach- A certain level of readiness is essential for any eGovernance project, basic ingredients such as in placing the necessary infrastructure and human resource capabilities of the organizations is vital. However, different organizations cannot be at the same level of eReadiness. There has to be an evolutionary approach to eGovernance so that outcomes are maximized and citizens reap early benefits from eGovernance.

eGovernance working culture- eGovernance requires imbuing its own culture which enables organizations to work in a systematic way. Most technologies pre-suppose a set of rational behaviour on the part of users. This element needs to be emphasized during the capacity building as well as in the life cycle of the eGovernance project.

Monitoring and evaluation- Close monitoring of eGovernance projects is necessary in both the pilot phase as well as during the actual working of the up-scaled project. This helps in early detection of problems and hence facilitates prompt corrective action. However, apart from periodic monitoring of eGovernance initiatives in the post-implementation stage, there would also be need for evaluation of the impact of such initiatives through independent agencies against parameters which would determine whether the objectives have been achieved or not.

Establishing Secure, Fail-safe, and Disaster Recovery Systems- Given the scale of potential e-Governance applications in the country and the prospective mammoth flow of data involved, the technological architecture on which such applications are mounted would need to be made not only secure but also fail-safe. Mechanisms would have to be incorporated which would put the systems in the 'safe mode' in times of crisis.

Sustainability- eGovernance initiatives need to be sustainable. Once it has been established that any particular initiative is the better way of providing services or information to the people or conducting the business of government, it should not be allowed to relapse on grounds of expediency.

Allowing Horizontal Applicability or Adoption- To make eGovernance more cost effective and successful, successes need to be adopted across organisations thereby minimizing costly repetitions and in many cases, failures.

Support for Localisation- for a country with multilingual society, eGovernance initiatives need to provide citizen interfaces in the respective local language.

eGovernance under continuous evolution- eGovernance represents a paradigm shift in the field of governance reforms. Bringing it about would have to be a continuing process which would require many adjustments.

Frameworks of eGovernance

In this section the eGovernance frameworks of South Korea and India have been discussed in order to give learners a flavor of how ICT can transform governance. South Korea has been successful in keeping their e-government readiness ranking at the top 5 for several years. They have adopted four dimensional framework focusing on demand and supply-driven strategy. Within the system, depending on the supply and demand, requisite infrastructures have been developed and change management have also been conducted.

Demand-Driven (In consultation with citizens and entrepreneurs)	Supply-Driven (Requisite Government services made online) Front-Office
Change Management Process (Commitment and drivers of changes)	Adequate Infrastructure (Enabling publicly available infrastructure) Back-Office

Figure 1.1 A Four Dimensional Framework focusing on Demand and Supply Strategy

Reflective Activity: Essay/Write-up:

Are countries in Africa ready to unleash eGovernment?

1. Discuss the pros and cons of electronic delivery of government services.
2. How has the digital divide affecting transformation of public or government services in Africa?
3. Where do African countries stand with respect to the stage model for eGovernment implementation?
4. What makes the implementation issues that surround eGovernment projects different from any other software development projects?

Conclusion

As it stands, African countries lack several ingredients of eGovernment readiness to unleash eGovernment. Factors that stand in the way of unleashing eGovernment in African countries are many. It would be good for learners to understand those issues or problems in Africa in order to be able design ICT-based solutions tailored to specific constraints and circumstances the countries are in.

Assessment

1. Clarity and completeness of the essay or write up, learners ability to prepare the write up using owns word as opposed to copying and pasting from the referenced sources as they are.

Unit Summary

ICT have emerged as a strong tool for development processes worldwide. Over the years, ICT has fundamentally transformed the governance systems of countries. However, the sector faces major challenges of tackling corruption and establishing the good governance constructs. The growing demand for transparency, accountability and other elements of good governance constructs also offers opportunities for governments to continuously improve their governance systems. ICT plays an important role in addressing these challenges and pushing countries governance systems to the next level.

Unit Assessment

Instructions

A solid understanding of the following items is a necessity, in case of doubts learners are advised to read the notions by going back to the specific sections where the ideas have been presented as well as the reference materials recommended.

1. Scope of eGovernment,
2. The key elements of eGovernment,
3. Characteristics of good governance constructs,
4. Principles and frameworks of eGovernance
5. Explain the difference types of eGovernment interactions using examples
6. What are the most important impacts of ICTs on the structure and processes of government organizations? Which impacts are already discernible?
7. What decision-making and problem-solving processes are emerging as the principal means of mutual adjustment?
8. What is the impact of increasing use of information-based, networked forms of organization on the institutional structures (e.g., oversight, budgeting, and accountability systems) that regulate governance?

Grading Scheme

The course facilitator is required to prepare subjective questions with respect to what is covered in this unit is required. The above questions are included as sample to aid in course module facilitators on how to prepare unit assessment questions, and the unit assessment weight should not exceed 10%.

Answers

1. Explaining G2G, G2B, B2B, etc using examples
2. Responses similar to: Ease of access to information, ability to provide services online, etc
3. Responses similar to: Virtual conferences, online discussion forums, online seeking of public input, etc
4. Enhancing transparency and accountability.

Unit Readings and Other Resources

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Unit 3. ICT and Agriculture

Unit Introduction

Increasing the efficiency, productivity and sustainability of farms is an area where ICT can make significant contribution. Countries both in the global South and North are harnessing ICT towards meeting the information and knowledge needs of farmers thereby transforming the agriculture sector- streamlining agricultural production, marketing and post-harvest activities. This unit introduces you to ICT-powered agriculture which essentially means the enhancement of agricultural and rural development through improved information and communication processes. You will be introduced to the key drivers of ICT in agriculture, and ICT powered agricultural development in depth. In order to solidify your understanding or grasp of ICT in agriculture, case studies on best practices of ICT in agricultural and rural development have also been presented.

Unit Objectives

Upon completion of this unit you should be able to:

- Analyse the role of ICT in agriculture;
- Design, implement, and evaluate appropriate and sustainable ICT components of agricultural projects.
- Design ICT-based services adaptable to the needs of rural areas;
- Demonstrate different ways in which ICT can be effectively integrated in agricultural systems; and
- Develop the skills to critically evaluate ICT-based agricultural systems against best practices, principles and standards.

Key Terms

Pervasive connectivity: connectivity anywhere.

Agricultural data warehouse: a repository for agricultural data.

Learning Activities

Activity 1 - Application of ICT in Agriculture

Introduction

Agriculture is an important sector where the majority of rural population in developing countries depend on it. However, the sector faces major challenges of enhancing production in a situation of dwindling natural resources necessary for production. The growing demand for agricultural products, however, also offers opportunities for producers to sustain and improve their livelihoods. Information and communication technologies (ICT) play an important role in addressing these challenges and uplifting the livelihoods of the rural poor.

ICT has immense potential in transforming the agriculture sector. One area of application for ICT in agriculture is improving, through better management, the efficiency and sustainability in using inputs - land, soil nutrients, feed and fodder, water, energy, pesticides, labour and most importantly, information and knowledge[8]. ICT also helps reduce the negative effects of pests and disease and enable aversion and mitigation of risks such as inclement weather, droughts, floods and long term change in climate. Through innovation, ICTs continue to contribute to improving through put of farming systems, increasing the quantity, quality and marketability of outputs (e.g. food, energy and biomaterials), supporting their marketing and enabling their effective and efficient consumption by households and communities and their ultimate recycling.

In this unit a broader range of the applications of ICT in agriculture will be discussed. Case studies that portray how ICT is instrumental in changing the livelihood of farmers and the rural poor have also been presented so that learner can take stock of the transformative power of ICT towards instigating initiatives creatively to address developmental challenges of our time.

Activity Details

The Nature of Agriculture in Africa

In an attempt to give you a better picture of the developmental challenges that African countries face with respect to transforming their agricultural system and, towards broadening learner's perception of the roles that ICT can play in terms of mitigating or easing problems surfaced in the agricultural sector of African countries, a description of the characteristics and the nature of agriculture in African countries' have been presented.

Agriculture in most African countries' is regarded as the backbone of economy and provides a living for about 60 percent of the entire workforce [2]. In other words Africa is comprised of a majority of agrarian countries- dependent on agriculture as a major component of their development and of the livelihoods of the bulk of its population. The importance of agriculture and its potential for development in Africa is widely acknowledged.

However, it is well documented that African countries need to modernize their agricultural system and ICT can play fundamental role in the modernization process- the design of ICT-based solutions that can streamline productivity on the farms as well as enabling farmers to have better access to markets and value chains are critically required. The following are some of the items that characterize the current state of agriculture in Africa[1]:

- Farm-level production costs in Africa are often relatively low;
- A lack of coherent, cross-ministerial policies and leadership on agriculture;
- Access to input and output markets is often weak;
- Access to financial intermediation services is weak;
- Access to critical information is limited or nonexistent;
- Low average cereal yields per hectare;
- Predominantly rain-fed agriculture;
- Agricultural mechanisation is poorly developed or farmers in Africa still mainly use obsolete and inefficient technologies;
- African soils are heavily degraded and depleted of nutrients;
- Farm sizes are shrinking;
- Weak infrastructure;
- High production and transport costs;
- Considerable size of people living in most African countries are food insecure;

Problems that surround agriculture in Africa are numerous, and ICT can play an important role in meeting these challenges. However, of non-technical nature such policy related issues need different treatment as they cannot be tackled using ICT. However, problems related to access to input markets and values chains can be effectively mitigated via ICT-based cost effective solutions.

In general the role that ICT can play in addressing these challenges is increasing as personal ICT devices – such as mobile phones or tablet PCs are becoming more widely available. ICT, when embedded in broader stakeholder systems, can bring economic development and growth as it can help bridge critical knowledge gaps.



ICT and Agricultural Development

Over the past thirty years ICT technologies have been introduced in the agri-food sectors. Important milestones were introduction of computers (1980s), internet, email and mobile phones (1990s), and Global Navigation Satellite Systems (GNSS), wireless communication and social media (last decade). Modern farms make use of one or more of the following ICT: computers with a farm management system to keep track inputs, outputs and economics, weather forecast, early warning and decision support systems for crop management, auto guidance systems for controlled traffic on fields, tractor mounted board computers for steering of sprayers and other machines in a preferred way, and data registration systems to meet legal and chain requirements.

However, the uptake of these solutions has been slow due to a number of important yet unresolved issues. For instance, farmers register a large amount of data. The use of this data is still limited because handling is still far from easy in optimization of crop, farm and chain management. Problems are related with limited standardization, data protection and lack of optimization models. There's still a large potential in stimulating adoption of current ICT, but future ICT technologies even promise more potential gains. At the same time, it is believed that the agro-food sector itself can also play an important role in the development of future ICT.

Precision Agriculture and modern society could play an important roles in accelerating adoption of ICT technologies. Precision Agriculture requires fast and accurate handling and interpretation of GEO-data. Variation in soil and crop conditions are detected by various sensors and translated into sites specific actions. External data bases have to be consulted. Simple web service should facilitate this decision making. Think of digital diagnosis of crop stress and associated crop care advice. Controlled traffic farming and robotics require robust communication and GNSS networks. Society want sustainable food production. This means that farmers and food chains have to proof with data that their production systems are sustainable and risks are minimized (tracking and tracing). So, farm data will be used outside the farm by various other parties with different objectives (supply chain, food chain, governments, logistics, consumers). Social media allow new ways of promotion and sales of farm products.

The wider adoption of ICT in agriculture is of strategic importance to five main stakeholder groups:

- **Businesses:** businesses, associations, other organizations
- **Farmers:** individuals; organized and informal associations
- **Researchers:** researchers; educators and trainers
- **Government:** ministries of agriculture, and other relevant departments and agencies
- **Citizens,** both as consumers and as custodians of the environment, for instance through civil society organizations.

To identify the ways in which ICT can help agriculture, it is useful to view the farming life cycle as a three-stage process:

Pre-cultivation: including crop selection, land selection, calendar definition, access to credit, etc.

Crop cultivation and harvesting: including land preparation and sowing, input management, water management and fertilization, pest management, etc.

Post-harvest: including marketing, transportation, packaging, food processing, etc.

Some aspects of how ICTs can assist the development of agriculture are crosscutting, like the use of geographical information systems (GIS) for land-use planning, while others are broader than agriculture, such as their use in climate change adaptation.

Key Drivers of ICT in Agriculture

Five main trends have been the key drivers of the use of ICT in agriculture, particularly for smallholders [3]:

1. Low-cost and pervasive connectivity,
2. Adaptable and more affordable tools,
3. Advances in data storage and exchange,
4. Innovative business models and partnerships, and
5. The democratization of information, including the open access movement and social media.

These drivers are expected to continue shaping the prospects for using ICT effectively in agriculture particularly in developing-countries.

Low-Cost and Pervasive Connectivity

The pervasiveness of connectivity—to mobile phones, Internet, and other wireless devices—is due to a number of factors, including decreases in costs, increases in competition, and expansion of last-mile infrastructure. Several trends, working in tandem, are making ICT devices and services more affordable in ways that also extend access to small-scale producers.

Mobile phones are in the vanguard of ICTs in agriculture. By the end of 2011, over 6 billion mobile phone subscriptions—or more accurately, subscriber identity module (SIM) cards—are expected to be in use worldwide (Wireless Intelligence 2011). Mobile phone penetration in the developing world now exceeds two subscriptions for every three people, driven by expanding networks in Asia and in Africa. The ability to purchase a low-cost mobile phone is complemented by the expansion in telecommunications infrastructure; most countries now have more than 90 percent of their population served by a cell phone signal, including coverage in rural areas. This rapid expansion results from enabling regulations that ensure competition in the telecommunications sector as well as from high demand for mobile phone subscriptions.

The reach and affordability of broadband Internet is also improving dramatically—though somewhat slower—in developing regions. In 2010, the number of Internet users surpassed 2 billion and over half of these users are now in developing countries. Internet connectivity around the world has grown exponentially since 2000, by over 480 percent (Internet World Statistics, 2011). The price of bandwidth has continued to drop as well, driving down the costs of extending connections to isolated communities. In sub-Saharan Africa, which lags other regions in ICT accessibility, a recent surge of investments in international undersea cables and inland infrastructure to complete those connections is making ICTs services substantially more accessible and affordable across Africa.

Adaptable and More Affordable Tools

The proliferation of adaptable and more affordable technologies and devices has also increased ICT's relevance to smallholder agriculture. Innovation has steadily reduced the purchase price of phones, laptops, scientific instruments, and specialized software. Agricultural innovation in developed countries has become more applicable to developing-country needs. The intuitive design of many technologies and their capacity to convey information visually or audibly make them useful to people with limited formal education or exposure to technology.

Geospatial information is also becoming easier to access and use as mapping tools, such as Microsoft Earth or Google Maps, bring geographical data information to regular users. Scientists and development organizations have created substantial sets of georeferenced data on population, poverty, transportation, and any number of other public goods and variables through more affordable, usable geographic information systems available on standard PCs and mobile devices using web-based tools. Satellite images and similar representations have improved exponentially in quality and detail. These tools and remote sensors use less energy and require less human attention than in previous years. The capacity to overlay geospatial information with climate and socioeconomic data opens many options for analyzing biophysical trends (such as erosion or the movement of pathogens), making projections (about the effects of climate change or the best location of wholesale markets in relation to transport infrastructure), and selecting particular groups to test new technologies or farming practices (for instance, identifying farmers that are most likely to benefit from using e-vouchers to purchase fertilizer).

Mobile-based applications are also becoming more suitable for underserved and isolated communities, especially through feature phones. Drawing on simple, available technologies such as SMS, service providers can offer mobile banking, other transactional services (selling inputs, for example), and information services (market price alerts). Other publicly and privately provided services such as extension and advisory services are delivered over mobiles, which are increasingly not just “phones” but are actually multifunctional wireless devices.

Advances in Data Storage and Exchange

Greatly increased data storage capacity and the ability to access data remotely and share it easily have improved the use of ICT in agriculture. Sharing knowledge and exchanging data have created opportunities to involve more stakeholders in agricultural research—involvement facilitated by an improved e-learning environment and networking capacity. Advances in data storage and sharing have improved the ability to exchange information—for instance, between departments and levels of government—and avoid costs associated with data transmission charges.

Improvements in data storage and sharing have underlying causes. The capacity of hard drives and the speed of microprocessors have continued to rise, making it dramatically cheaper to store data. Cloud computing offers access to numerous shared computing resources through the Internet, including sharable tools, applications, and intelligently linked content and data. These advances address some of the information and communication constraints of agricultural research institutions, government offices, cooperatives, and development organizations. Benefits of enhanced data capacity range from more accurate targeting of agricultural development programs to better preparation for handling surpluses or scarcities at the farm level.

New Business Models and Public-Private Partnerships

The development and use of many ICTs originated in the public sector but were quickly dominated by the private sector when their profit potential became clear. The public sector maintains great interest in ICT as a means of providing better public services that affect agriculture (for instance, land registration, forest management, and agricultural extension services), as well as for connecting with citizens and managing internal affairs. Private sector involvement in some of these efforts has enhanced the access, affordability, and adaptability of ICTs for development. Unlike other development strategies, which often struggle to survive or be scaled because the public sector cannot fund them, development strategies featuring ICTs have benefited from growing private sector interest and public demand.

The entrepreneurial nature of ICTs attracts new partnerships and forms of investment. Mobile phone applications, software design, local language customization, and remote transaction services represent only a fraction of the opportunities for continued innovation. Private companies that have invested in technology and applications are often interested in working with the public sector to provide their products and services to smallholders. Mobile network operators, for example, can invest by providing large text packages at a lower price, collecting premiums, distributing payments, or participating in extending networks to rural areas. Commercial enterprises such as processors, input suppliers, and exporters are also motivated to invest in ICT because they often lead to increased efficiency and revenue as well as extensions to client bases like isolated farmers.

New forms of business incubation and knowledge brokering are also contributing to ICT in agriculture. The private sector has a keen interest in investing in firms that come out of such incubation schemes, speculating on the ability of an innovative idea to expand into a highly profitable enterprise. Incubators identify additional investors and other suitable partners, including technical experts. In many instances, they develop enterprises through which private and public providers of agricultural services collaborate to deliver products more efficiently to farmers; in developing, sharing, and capitalizing on innovations for agricultural development, they almost always use ICT and often develop new ICT tools.

Knowledge brokering, in which a private enterprise provides information for a fee (for example, farmers obtain market, price, crop, and weather information via their mobile phones), is also gaining traction. This business model reduces the burden on the public sector while increasing the abilities of brokers and farmers to profit from information sharing.

Democratization of Information, the Open Access Movement, and Social Media

The democratization of information and science facilitated by ICTs is also contributing to agriculture and rural development more broadly. Vast quantities of information held by institutions and individuals are becoming visible, publicly accessible, and reusable through the open access movement. Many governments and organizations such as the World Bank, the Food and Agriculture Organization, the Consultative Group on International Agricultural Research are aiming to make data like national surveys or research findings publicly available. These actions have not only improved transparency and accountability but have invited the public, private, and research sectors to participate in solving long-term economic and social problems, including those involving agriculture.

The expansion of open access software also enables grassroots community organizations to share knowledge with one another. Social media, once used purely for entertainment, has great potential to be used for knowledge sharing and collaboration even in agriculture. Although penetration of the most popular social medium, Facebook, was estimated at just 3 percent in Africa and almost 4 percent in Asia in 2010, compared to 10.3 percent (over half a billion users) globally (Internet World Statistics, 2011), recent geopolitical events highlight the effectiveness of social media for sharing information and motivating collective action which are two key features of agriculture development.

Finally, crowdsourcing, in which scientists, governments, and development organizations request feedback from farmers and consumers through devices like mobile phones, is also facilitating agriculture development. Farmers can use SMS to send critical local agricultural information like incidences of pests or crop yields that was previously difficult to obtain without expensive surveys by researchers. Using the digital tools available, consumers can also provide information related to changing consumption patterns and tastes to private enterprise.

ICT in Agricultural Knowledge Management

Knowledge management can be defined as the fact or condition of knowing something with a considerable degree of familiarity acquired through experience, association or contact. Knowledge consists of the attitudes, cumulative experiences, and developed skills that enable a person to consistently, systematically and effectively perform a function (William and Michael, 2005). It is an integration of explicit and tacit knowledge. Explicit knowledge refers to all aspects of formal, systematic, recorded, communicated and shared knowledge that is made accessible through a variety of information delivery systems. Tacit knowledge on the other hand is highly personal, created by doing, trial, error, reflection and revision. Knowledge management encompasses processes and practices concerned with the creation, acquisition, sharing and use of knowledge, skills and expertise

Knowledge is considered as the fourth production factor after labor, land and capital (AFAAS, 2011) and is particularly critical in the agricultural sector. Making relevant knowledge accessible to the farming community helps improve production, productivity and brings higher returns. If the agricultural practice of smallholders is not backed up by modern agricultural knowledge and information, agricultural households are likely to remain trapped in low productivity, food insecurity and poverty. In the context of Ethiopia, generating new agricultural knowledge and information and making it available for use by smallholder farmers is important in promoting sustainable livelihoods and reducing rural poverty[4].

Various entities are engaged in the creation and development of information and knowledge. Likewise, several repositories and intermediaries play their role to bring the information and knowledge to the ultimate users. Agricultural knowledge is created from modern and indigenous sources. The modern knowledge is created through scientific research (and therefore it is explicit knowledge) by universities and research institutes. Indigenous knowledge or tacit knowledge, on the other hand, refers to traditional knowledge, innovations and practices of local communities and is developed outside the formal education system.

Agricultural information and knowledge created from these sources is stored in various forms before it is disseminated for use. The main repositories of such knowledge include publications, audio visuals, and websites. The stored knowledge and information is then disseminated to users, such as rural farmers, through intermediaries notably during trainings, field visits, exhibitions, publications, and using traditional forms of ICT (TV and radio), modern forms of ICT (internet, mobile phone, etc), and others

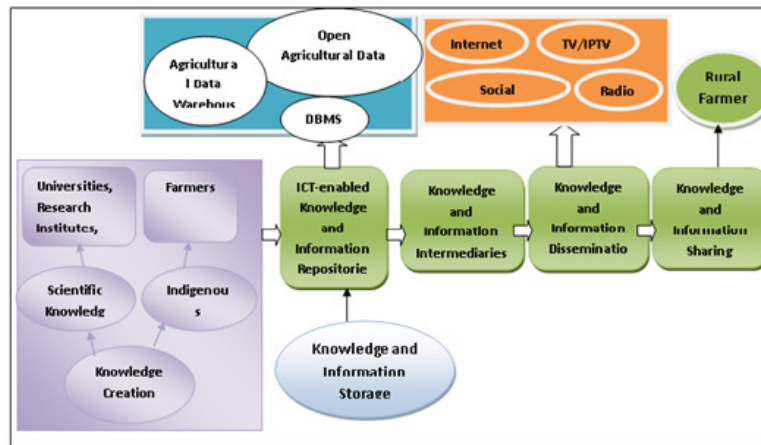


Fig 3.1 ICT-enabled Agricultural Knowledge Management

Knowledge both explicit and tacit generated in the form of scientific as well as indigenous are stored in digital medias or repositories. Knowledge and information intermediaries collect, organize, exchange, and distribute knowledge and information to rural farmers via the Internet, social medias, TV, Radio, etc.

Reflective Activity : Essay/Write-up

1. How or in what ways can ICT help smallholder farmers with respect to knowledge and information sharing?
2. What are the key challenges of African countries in establishing ICT-enabled knowledge management systems?
3. What benefits would agricultural data warehouse bring to the sector?
4. Discuss what open agricultural data or open data in agriculture mean?

Conclusion

Knowledge-based systems have proven to be a key part of businesses worldwide and it is important to replicate that success in the agriculture sector. It would be good for learners to identify the key drivers or factors that promote the use of ICT-enabled knowledge management system in agriculture. We are in an era where data is driving every sector and the agricultural sector is no exception.

Assessment

1. Completeness of the key drivers or enabling factors identified, understanding the factors impact the establishment of ICT-enabled knowledge management systems in Agriculture.

Activity 2 - Towards Universal Access to ICT in Rural Areas

Introduction

Making ICT Infrastructure, Appliances and Services Accessible and Affordable in Rural Areas

In developing countries ICT infrastructure, appliances, and services are underdeveloped. Making ICT infrastructure, appliances and services accessible and affordable in rural areas have paramount significance in that it would enable smallholder farmers to get connected to knowledge sources which enable them to compete in complex and rapidly changing global markets. There are several challenges that need to be addressed to make ICT infrastructure services accessible in rural areas. Chief among them are lack of permanent and affordable electricity power and lack of affordable connectivity and bandwidth are two of the sternest challenges in designing ICT-based services or solutions.

Creating affordable ICT services in rural areas is a complex challenge. In these areas, the “last mile” of telecommunications infrastructure is provided at a very high cost that may not be justified by the resulting use and effects of the telecommunications network[5]. The challenge of affordable access to ICTs in rural areas can be compounded at the supply as well as the demand end of the service-provision chain. To supply ICTs and related services in rural areas, the main challenge is the high level of capital and operating expenses incurred by service providers. On the demand side, rural adoption of ICTs in developing countries is curtailed by low availability of complementary public services, such as electricity and education, and by the relative scarcity of locally relevant content

Recognizing the equity implications of access to ICTs, governments have adopted regulatory policies to enable the rollout of ICT infrastructure and the supply of services in rural areas, and they have addressed low rural demand by introducing locally relevant content in the form of e-government and e-agriculture services. The task of regulation policy has been to keep pace with technological developments while maintaining licensing policies geared toward equity; in other words, to reduce inequalities within countries while maintaining sound business reasoning within the telecommunications sector.

What is meant by accessible ICT?

Within telecommunication policy, “access” can be understood in relation to two broad concepts: universal service and universal access (Gasmi and Virto 2005). “Universal service” is a policy objective primarily used in developed countries. It focuses on upgrading and extending communication networks so that a minimum level of service is delivered to individual households, even in the least accessible areas. US objectives are generally pursued by imposing universal service obligations on network operators. “Universal access,”² a policy objective more typical for developing countries, seeks to expand the geographic access to ICTs of the population at large, and often for the very first time. UA obligations provide for a minimum coverage, especially of remote communities, thereby allowing all citizens to “use the service, regardless of location, gender, disabilities, and other personal characteristics”.

Characterization of Universal Access and Universal Service

The following table outlines the characteristics of universal access and universal service in terms of their availability, accessibility, and affordability.

Aspect	Universal Access	Universal Service
Availability	Focused coverage	Blanket coverage
	Public access (e.g., at a pay phone or telecenter)	Private service on demand
	Free emergency calls	Free emergency calls
Accessibility	Walking distance, convenient locations and hours	Simple and speedy subscription
	Inclusively designed premises (e.g., for wheelchair users); inclusively designed terminals or available assistance (e.g., for the blind or deaf)	Inclusively designed terminals and services (e.g., for blind or deaf people)
	Assistance from an attendant	Assistance through the terminal (e.g., by making calls or viewing help pages for the web)
	Adequate quality of service (e.g., having few failed call attempts)	Reasonable quality of service (e.g., having few dropped calls)
Affordability	Options of cash and card payment	Cost of average monthly usage is a small percentage of monthly GNI per capita
	Options of cash and card payment	Options of cash, card, and electronic payment
	Payment per use (e.g., for a single call or message or an hour of Internet access)	Flat rate, bundles of services or low monthly subscription fee

Table 3.1 Characteristics of Universal Access and Universal Service

In designing policy interventions to promote equitable access to ICTs, the technology and its users must be considered as forming a socio-technical system through which improved ICT access translates into improved rural livelihoods and sustainable benefits for rural residents. Many authors have considered access to ICTs holistically, with an aim of understanding different aspects of how access is enabled or impeded, including technological, socioeconomic, and cultural aspects. This module uses the Access Rainbow Framework (Clement and Shade 2000), depicted in figure 3.2, to understand access to ICTs. The Access Rainbow Framework

demonstrates the multifaceted nature of access to ICTs and captures the socio-technical architecture instrumental to it. The framework goes beyond a mechanical understanding of ICT access by including enablers of ICT such as locally relevant content, ICT literacy, proximal ICT use, and social mechanisms for governing ICT use.



Figure 3.2: Access to ICT Infrastructure, Appliances, in Services and the Rainbow
Access(Clement and Shade 2000)

The Access Rainbow provides a framework for discussing access to ICT infrastructure, appliances, and services. The “carriage facilities” layer is a physical technology layer consisting of installed network capacity, network connectivity, and interoperability standards. In this unit, this layer is interpreted as access to ICT infrastructure. Access to ICT appliances is captured by the physical layer of ICT hardware devices and the logical layer of software tools on these devices. With its twofold (hardware and software) nature, access to ICT appliances links the supply of ICT infrastructure with the provision of services targeted at end users.

Access to ICT services is a more unstructured concept, consisting of:

- The readily availability of content (resources), fulfilling users’ roles as citizens, producers, and consumers;
- The readily availability (to those who are not experts in the technology) of network access and appropriate support services through commercial vendors;
- The availability of formal and informal learning facilities for developing network literacy; and
- The ready availability of channels through which individual users can participate in decisions about telecommunications services, their social inclusiveness, and the public accountability of their provision.

In considering interventions to improve access to ICTs, practitioners must consider the complexity of access to ICT infrastructure, appliances, and services. It is important to locate the access layer within which an intervention is anchored and to assess how it relates to contingent aspects of access.

Affordability as a Function of Pricing and Business Model

An affordable universal service is one in which the “cost of average monthly usage is a small percentage of monthly gross national income (GNI) per capita” (Dymond et al. 2010). As a concept, affordability is easier to measure than access. The ITU in its measuring the information society annual report uses ICT Price Basket (IPB) metrics to measure affordability of ICT services—a composite affordability measure based on three sub-baskets (fixed telephone, mobile cellular and fixed broadband Internet services) [6]. The report points out that fixed-line broadband Internet was the single most expensive and least affordable service in developing countries as of 2009. Access is not the only hurdle that developing countries need to cross in order to dispense the benefits of ICT to a broader mass of citizens. For those who have access, affordability is also a significant hurdle to cross in.

The Access Rainbow Framework proposed by Clement et al. (2000), depicted in Figure 3.2, helps in understanding issues of affordability and sustainability, because it represents the layered system of interdependencies within which technology diffusion, business development, and regulatory policies take place. For example, the ICT layer carrying the highest value proposition for end users is the content/service layer. The framework makes it possible to consider the financial viability of all contingent layers (network capacity, availability of appliances, customer support, and so on) and how they may affect the value derived from the content/service layer.

From a regulatory standpoint, the Rainbow approach captures the significance of the separation between layers, most prominently the separation between the carriage and the content layers. Focusing regulatory efforts within layers and enabling competition within and between layers is central to achieving quality end-user services at affordable prices. From a regulatory policy perspective, the layered structure illustrates the trend in policy to enable competition among technologies delivering comparable functionality by following the principles of competition, technology neutrality, and licensing flexibility.

Ensuring competition within each of the layers is a longstanding policy priority, especially where the economies of scale are conducive to monopolistic market structure. Market liberalization and free entry give incumbents incentives to pursue a higher quality of service

In addition to competition, technology neutrality is another leading regulatory policy principle for ensuring the affordability of ICTs. Technology neutrality is the principle of refraining from specifying technology requirements within telecommunications licenses.

Reflective Activity: Essay/Write-up

1. ICT penetration is the lowest in developing countries or countries in the global south. In this activity you are required to exhaustively identify the constraints that contribute for the sparse diffusion of the Internet and ICT in general.
2. Explain in the detail the key challenges that stand in the way of universal access to ICT services in Africa particularly in rural areas.
3. What does constitute the ICT Price Basket(IPB)?
4. Explain the benefits of technology neutrality in making ICT services affordable.
5. What is a universal access fund mean?

Conclusion

ICT penetration is one of the most important hurdle to cross in order to unleash the full potential of ICT for development. ICT penetration is the lowest in developing countries or countries in the global south. In this activity a detailed discussion of the constraints that contribute for the sparse diffusion of the Internet and ICT in general have been made. It would be good for learners to have a good understanding of the factors in order to be able model or develop tailored ICT-based solutions.

Assessment

1. Completeness of the constraints identified, understanding the constraints on ICT penetration that impact ICT interventions to developmental challenges.

Activity 3 - The Driving Factors to Universal Access to ICT

Introduction

Key Challenges and Enablers of Making ICT Both Affordable and Accessible:

The following are key enablers of making ICT more widely and affordably available to rural people in developing countries:

- Partnerships;
- Telecommunication regulatory frameworks; and
- Policy
- Partnerships

Considering the multilayered nature of the problem of ensuring affordable rural access to infrastructure, devices, and services, partnerships among organizations with different specialties, capacities, and profit motives appear to be a key way to improve access and affordability.

Partnerships serving as critical mechanisms for improving rural ICT access can take the form of partnerships within the public sector, negotiated public-private partnerships, private agreements among stakeholders in the telecommunications sector, or informal understandings between service providers and stakeholders at the community level. Enabling such partnerships and maintaining them remains a key government role.

For example, the public sector played a considerable within the M-PESA collaborative partnership (see who involved in “M-PESA’s Pioneering Money-Transfer Service” in the Case Studies section). This role involved financially supporting the collaboration among mobile network operators (MNOs) during software development.

Telecommunication Regulatory Frameworks and Policy Challenges

Although the evolution of ICTs in developing countries has long to go, it has moved significantly forward in the past decade. The rapid expansion of mobile phone networks and market uptake of Global System for Mobile Communication (GSM) technologies following liberalization and deregulation are the most frequently cited examples of this evolution.

Informed and effective regulation is necessary for creating an enabling environment that will maximize entrepreneurs’ abilities to expand market offerings and minimize the negative effects of competition on consumers. Barriers such as a monopoly operator, excessive licensing regimes in some contexts (for example, requiring local community networks to have licenses) can negatively affect business potential.

At the other end of the spectrum, a supportive fiscal and financial environment and entrepreneurs' access to financial services can enable and increase the number of socially oriented services. Significant regulatory issues in the telecommunications sector include taxes, licensing, liberalization, and competition policies. Taxes on communication services strongly influence the affordability of ICTs in Africa, for example, given the low average incomes. Import duties on IT equipment, value added tax (VAT) (ranging from 5 to 23 percent) on goods and services, and excise taxes on communications services all raise prices, discouraging use. Excessive licensing can also stifle the delivery of various content-based ICT services.

Regulations on content broadcasting should be synchronized with pure data transmission regulations (UNCTAD 2010). In terms of competition, policies fostering the effective management of competitive markets, interconnection regimes, and mobile termination rates can provide incentives to invest in quality of service, differentiation, and innovation.

With the increasing adoption of ICTs and growing prominence of ICT-enabled services in consumers' lives in developing countries, it is worth emphasizing the significance of consumer protection regulation for ensuring the effective governance of multilayered ICT access. Recurrent problems include gaps between advertised "headline" broadband access speeds and what subscribers actually experience, lack of transparency in the pricing of mobile voice and data services, lack of effective mobile number portability, and excessive SMS pricing.

Consumer-focused regulations should also target improvements in the legibility and ease of comprehension of transactions, made possible through improved ICT access. Consumer protection can pursue such goals through measures for mobile phone number registration, identity verification, confidentiality, and privacy.

Trends and Issues in Making ICT Affordable in Rural Areas

"Fixed-mobile convergence" is the increasingly seamless connectivity among wired and wireless networks, devices, and applications, which permits users to send and receive data regardless of device and location. Convergence is the result of converting content formats (text, images, audio, video), devices for creating and communicating this content, and telecommunications infrastructure to digital standards.

Device convergence allows devices to support different functionalities and different network access technologies. Service convergence means that end users are able to receive comparable services via different devices and technologies for accessing networks. Network convergence means that a single network is able to carry voice and data formats and can support access by different technologies.

Convergence (as the name implies) blurs the distinctions between the domains of Internet service providers, cable television media companies, fixed-line telecommunication companies, and operators of mobile telephony networks (see figure 3.3 below). With this context in mind, the discussion that follows examines how technology trends in infrastructure, appliances, and services can influence the delivery of affordable ICTs in developing countries

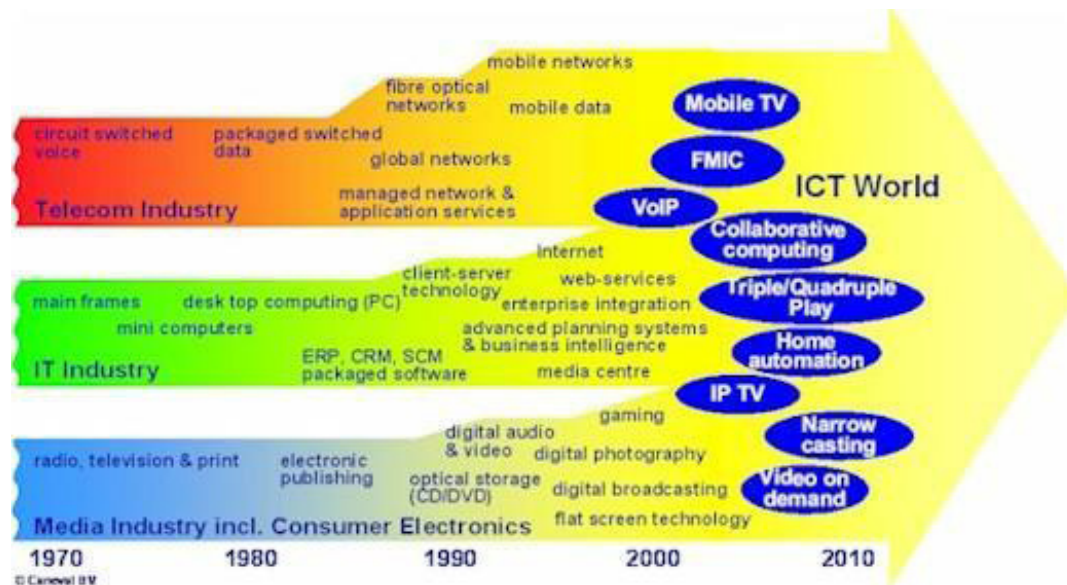


Figure 3.3: Telecommunications, IT, and Media Industry Convergence (Source: Caneval Ventures, "ICT and media industry" (<http://www.caneval.com/vision/ictmediaindustry.html>, accessed June 2015).

Infrastructure

What are the current wired and wireless options to improve domestic backbone and "last mile" connectivity? As noted, wired telecommunications infrastructure tends to reach rural areas in the wake of complementary rural access infrastructure such as roads and electricity and the expansion of public services such as education. The lag between the arrival of complementary infrastructure and public services and the establishment of wired ICT infrastructure in rural areas can be considerable, but the introduction of wireless, especially mobile, infrastructure is bound neither by the presence of roads nor by access to the electricity grid.

Rural infrastructure development needs to be considered in light of the different opportunities offered by wired and wireless technologies and the fixed-mobile convergence occurring throughout the ICT sector. Sunderland (2007) notes that fixed-mobile convergence differs in developed and developing countries, where fixed-line tele-density is low. As a result, convergence in developing countries largely amounts to convergence in the delivery of Internet access and voice telephony services over wireless networks. For example, in rural Africa where the tele-density of fixed networks is low and their rollout can be prohibitively expensive, fixed-mobile convergence enables the use of wireless "last mile" infrastructure, while the backhaul traffic is carried on fixed fiber-optic cables because of their high capacity. In small-island developing countries, fixed mobile convergence allows for international connectivity via satellite rather than undersea cable.

Telecommunications networks comprise a hierarchy of links that connect users at the "edge" of a network to its "core," also called the "backbone" (the high-capacity links between switches on the network). The backhaul portion of a network consists of the intermediate links between sub-networks at the user-end and the core network.

In considering how best to develop affordable telecommunications infrastructure in developing countries, all three connectivity segments of the network need to be taken into account:

- The international and domestic connectivity that makes up the network's backbone capacity;
- The domestic backhaul connectivity that enables the intermediate links; and
- The local loop or "last mile" connectivity that serves end-user access at the edges of the network.

Wireless infrastructure may be an economical option, but it has certain cost constraints. Buys et al. (2009) show that the probability of the presence of mobile tower base stations is positively correlated with the potential demand (population density, per capita income), as well as with the absence of factors that increase operational and capital expenditures, such as elevation, slopes, lack of all-weather roads, unreliable power supplies, and even insecurity.

At the carriage level, network convergence is associated with the transformation from circuit-based public switched digital telecommunication networks (PSTNs) to packet-switched networks using the Internet Protocol (IP) and known as next generation (NGNs). Both PSTNs and NGNs are made up of telephone lines, fiber-optic cables, microwave transmission links, mobile networks, communications satellites, and undersea telephone cables.

The difference between the two kinds of networks lies in their switching mechanisms. Under circuit switching, the connection is established on a predetermined, dedicated, and exclusive communication path for the whole length of the communication session. Consequently, PSTN connectivity is costly. In packet-switching protocols, such as IP, the communicated data are broken into sequentially numbered packets, each of which is transmitted to the destination via an independent path, and then the packets are reassembled. In packet-switching, the potential for congestion, packet loss, and delay can mar the quality of the connection. A comparison between traditional fixed-line telephone services and voice over IP (VoIP) clearly demonstrates the difference between the two types of networks. NGNs completely separate the packet-switched transport (connectivity) layer and the service layer, enabling any available fixed-line carriage infrastructure to be used efficiently for any service.

Domestic Backbone and Rural Backhaul Connectivity

As end users' demand for additional bandwidth grows, insufficient domestic backbone can pose a considerable challenge to the roll-out of fixed-line broadband services. In the mobile sector, insufficient backhaul capacity is becoming a limitation, particularly with the increase of rural 3G data use. Government interventions in support of rural backhaul solutions have included the introduction of public-private funding mechanisms, construction subsidies, and the rollout of fiber-optic networks connecting public institutions (Rossotto et al. 2010). Complementary regulations can be used to ensure competitive conditions in the provision of domestic backbone and rural backhaul. The policy tools for supporting domestic backbone rollout and rural backhaul connectivity include infrastructure sharing, functional separation, and cross-ownership restrictions, allowing for inter-platform competition (Dartey 2009).

Local Loop or “Last Mile” Connectivity

The delivery of network access in the “last mile” is the most costly and challenging element of rural deployments. The technology options for delivering wired local loop broadband connectivity include the rollout of xDSL, cable, and fiber to the home infrastructure. Wireless options include the rollout of mobile (2G, 3G, 4G), wireless broadband (WiMAX, Wi-Fi, WLAN), and satellite very small aperture terminal (VSAT) infrastructure. Within cell-based (mobile) wireless standards, all users connect to a single base station, and the transmission bandwidth has to be shared among all users in the cell’s coverage area.

Within a short range, wireless broadband transmission is possible at relatively high data rates—hundreds of megabits (Mbps) to a few gigabits (Gbps)—but services of such high quality are not foreseeable for existing mobile standards. Conversely, mobile technologies have the advantage of reliability within a greater access range. Point-to-multipoint solutions, combining VSAT terminals with wireless broadband local access, are increasingly viable and promising. Unlike cell-based connectivity, satellite connectivity does not distribute the available bandwidth among the users; instead, each user is connected independently, so satellite solutions can offer better quality of service. Yet the low density of wired infrastructure, combined with the limited domestic fiber backbone in developing countries, makes wireless a practical option for connectivity in rural areas, despite the limitations imposed on users by sharing capacity.

As this discussion implies, finding the network solution that can ensure affordable ICT in rural areas can be an innovative, challenging, and exhausting process. The choice depends largely on the availability of technology, of rural backhaul, and of complementary infrastructure. It also depends on the flexibility and responsiveness of the regulatory framework to the prevailing technology constraints and opportunities.

Policies related to the development of rural wireless infrastructure require careful study of the trade-offs between affordability and usability. Policy makers must determine where the value lies (in terms of use) in developing the infrastructure. Regulatory policy must consider the trade-offs between reach, speed, frequency, and transmission. For example, the choice to use technology with low transmission power can lead, on the one hand, to a great increase in the available bandwidth per user, but on the other hand, it may require a direct line of sight between the antenna and the user. Consequently, the number of access points needed to cover a fixed area, and therefore the required capital expenditures, will rise considerably.

Several key technology parameters should be considered in decisions about the expansion of rural connectivity and the choice of technological delivery mechanism. They include the availability of spectrum frequencies, number of base stations needed to cover an area of specific size given a fixed operating frequency, achievable connection speed, data transmission rates, and downlink and uplink speeds.

Given the complexity of such decisions, the role of the regulatory environment should be to expand the set of viable technology options. Flexibility in allowing licensed and unlicensed use of operational frequencies can be advisable. Wellenius (2002) describes how Chile identified cost-effective solutions to reduce the gap between urban and remote areas in access to basic communications technology.

The “digital dividend” has been widely hailed as the solution to urban-rural inequities in digital ICT access. The “digital dividend” is the reassignment of operational frequencies that become available following the switch from analog to digital television broadcasting. The Geneva 2006 Agreement sets June 17, 2015 as the final date for protecting currently assigned analogue television transmission frequencies. The digital dividend spectrum is found between 200 megahertz (MHz) and 1 gigahertz (GHz). It offers a combination of transmission capacity and distance coverage conducive to the extension of wireless broadband infrastructure in rural areas. Using this spectrum, a few stations can transmit with high power, thereby providing Internet coverage to large rural areas where population is low and demand sparse. The advantage is the low capital expenditure required; the downside is the low bandwidth available to individual users. The process is accepted as inevitable, however, and it provides opportunities for efficient spectrum management in rural areas.

Appliances

From a user’s perspective, device convergence has two main aspects. First, users can access content in different formats (audio, data, location data, pictures, maps, text) and with different dynamic properties, produced by different authors, on the same device. Second, users can take advantage of different options (radio, GSM, Wi-Fi, Bluetooth, satellite) for accessing that content.

The evolution of appliances in the mobile phone market illustrates these two trends. The discussion that follows focuses on portable devices that support multiple functionalities or multiple connectivity options, because they are vast majority of ICT appliances available in the world today.

Portable devices, including but not limited to mobile phones, are starting to allow users dual (or multiple) mode flexibility. For example, dual connectivity (Wi-Fi/GSM and Bluetooth/ GSM) enables mobile phones to make both VoIP and standard mobile calls. Dedicated telephone devices are able to process VoIP phone calls using Session Initiation Protocol, as well as regular phone calls using analog signals. Gains in processing power allow functions with higher technology requirements to work on smaller devices (high-end smartphones and Netbook appliances). Conversely, bulkier stationary devices such as the desktop computer have evolved functionalities traditionally associated with more portable devices, such as VoIP telephony and on-demand radio and TV broadcasts.

Among rural users in developing countries, the trend is to move from mobile phones with basic voice and text message capabilities to feature phones. Feature phones are low-end phones that access various media formats in addition to offering basic voice and SMS functionality, capturing the functionalities of multiple ICT devices that are also available as standalone appliances. Rural consumers prefer the combined devices because of their affordability. Features appreciated by consumers in developing countries include digital camera, voice recorder, flashlight, radio, and MP3 player. Bluetooth and general packet radio service (GPRS) are the most widely available connectivity options in addition to GSM.

Services

Services entail much more than access to hardware; they encompass affordable access to locally relevant rural content through connectivity providers, content creators and disseminators, information intermediaries, social facilitators, information literacy educators, and the governance channels steering the performance of these services. Concerns with rural content have traditionally been alien to public policies aimed at universal service and universal access, but the convergence of the mass media and telecommunications sector, as well as the rise of the information society, make such concerns increasingly prominent and crucial to unleashing a virtuous cycle of ICT adoption and use in rural areas.

The service layer reflects the synergies (or lack thereof) among network infrastructure, connectivity modalities, access devices, and content. The dynamics of the worldwide content marketplace point to the dying out of traditional communications business models, which centered on tariffs anchored in use time, quantity of data transferred, or communications distance covered. Such models increasingly are replaced by more flexible subscription models and models centered on realized interactions and transactions, paid for via micropayments. In developing countries, where consumers are more price sensitive and less willing to pay, the trend toward micropayments poses a considerable challenge to content and value-added service providers. The challenge is compounded by the marginal success of government and donor efforts to provide content-driven rural services in developing countries.

Traditionally, rural information services focused on providing broadcasting (“push”) content, such as rural radio programming, but the ubiquity of mobile devices enables the sourcing and sharing (“pull”) of rural content. The presence of mobile technology as an authoring tool in rural areas presents an untapped opportunity to engage rural users in authoring content, thereby increasing the demand for existing rural infrastructure. Mobile devices, in combination with broadcasting technologies such as radio, enable rural residents to participate in public discourse and influence decision making.

The provision of rural ICT-based services in developing countries has a few discernible characteristics. One recurrent characteristic in successful business models is found at the literacy/social facilitation level of the Access Rainbow Framework. Successful business models manage to leverage social networks and social value (UNDP 2008). Engaging rural residents as individuals rather than as beneficiaries appears to be essential in delivering a worthwhile value proposition. Allowing rural residents to be trainers, to facilitate access to content, and to provide local support and maintenance appears to be a successful business strategy for the delivery of rural services.

Another trend to be noted is the divergence in focus and targets of local (especially rural) demand-driven information services relative to supply-driven services. Content-focused service innovations tend to respond to local needs within the entertainment, social networking, game, and music domains. If managed carefully, such services can be legitimate drivers of ICT use for demand-driven services in education, public awareness, health, and agriculture. Introducing immediately popular content is a way to attract and retain users. Once the user base is established, there is room for introducing more practical content, such as mobile money or banking.

Reflective Activities: Essay/Write-up

- Explain or describe on current or existing mechanisms on reassigning digital dividend frequencies, which one is efficient?
- Why is the delivery of network access in the “last mile” is the most costly and challenging element of rural deployments, and what can be done to address this challenge?
- What are the challenges that surround the roll-out of fixed-line broadband services particularly in rural areas?
- Do you agree finding the network solution that can ensure affordable ICT in rural areas via innovation is a timely issue towards addressing the developmental challenges of developing countries? If so which hurdles need to be crossed in?
- Explain what device convergence mean?

Conclusion

Improved telecommunication infrastructure coverage remains central to African countries development as well as economic transformation. It would be good for learners to understand the scale and nature of telecommunication infrastructure lag developing countries or countries in the Global-South are experiencing in order to be able design tailored ICT-based solutions for services.

Assessment

1. Clarity and completeness of the essay or write up, learners ability to prepare the write up using owns word as opposed to copying and pasting from the referenced sources as they are.

Activity 4 - ICT Powered Agricultural Development

Introduction

Enhancing Agricultural Productivity with ICT

The world is facing several challenges with respect to food security, the following are serious problems more specifically developing countries are facing:

A lack of food- demand for food has reached new heights, and predictions of future demand are discouraging. There is much concern about future food supply and demand on the basis of expected population growth as well as due to the large number of people still suffering from undernourishment.

A lack of nutrients- a lack of food is not the only problem. Almost one billion people were undernourished in 2010, and the lack of nutritious food has serious, long-term consequences for physical and mental health. More than one in seven of the world's people do not receive enough protein and carbohydrates in their daily diets. These people constitute 16 percent of the developing country population.

The rising prices- even with projected reductions in food insecurity, price spikes could keep staple food out of the reach of poor people. The 2008 price spikes led to starvation in many countries, hitting the net food importers—typically the poorest countries—the hardest. Ethiopia, Malawi, Tanzania, and Uganda experienced maize prices that were twice as high as in the previous year.

The changing climate- Climate change has made the challenges of food security and rising prices even more stark. Continued release of greenhouse gases increases the likelihood of unpredictable weather and temperatures.

How ICT can Improve Agricultural Productivity?

When farmers have access to biophysical and other yield enhancing technologies, frequently they do not know how to use them effectively to address their productivity challenges (for example, they may have fertilizer but not know the optimal amount to apply). ICT can fill this gap in knowledge. Global positioning systems (GPSs), radios, mobile phones, digital soil maps, and other ICTs give farmers information to use biophysical technologies appropriately (for example, nitrogen sensors can help to determine the correct fertilizer dose).

Similarly, governments or development partners may know that farmers are using new yield-enhancing technologies but may not have the capacity to understand their impacts. Data-mining technologies, decision-support systems, and modeling software that can clarify the impacts and outputs of yield-enhancing technologies are among the most promising means of linking productivity and ICTs.

ICT usage in improving agricultural productivity falls into three broad Categories:

- Remote Sensing Technologies- raw Data Collection.
- Information Management Technologies- making sense of the data.
- Dissemination Tools- getting the results to the stakeholders.

Remote Sensing Technologies- Raw Data Collection

The first type of ICT that improves productivity includes tools that collect agricultural data:

Geographical Information Systems (GIS)- collect geographic data through computer hardware and software to capture, store, update, and display all forms of geographically referenced information by matching coordinates and time to other variables. Data sets formed by GIS constitute “layers” of information (for example, on topography, population size, or agricultural household income) that can be merged and analyzed to establish relationships and produce maps or charts that visualize geographical traits.

Global Positioning System (GPS) is a satellite-based positioning and navigation system with three basic components: satellites that orbit the earth, control and monitoring stations on the earth, and the GPS receivers owned by users. GPS receivers pick up signals from the satellites, including precise orbital information (latitude, longitude, and ellipsoidal GPS altitude) of a given object or location, as well as the time. GPSs can function in any weather and are free for public use.

Satellite imagery- is an image of Earth taken from satellites in orbit. There are four types of satellite imagery: spatial (size of surface area); spectral (wavelength interval); temporal (amount of time); and radiometric (levels of brightness)—which capture a variety of variables about a given area of varying size. The resolution (in meters) of these images depends on the satellite system used and its distance from Earth; weather can interfere mainly with satellite systems utilizing visible wavelengths of light. The cost of the technology depends on the satellite system used, on whether new or archive imagery is purchased, and on possible georeferencing to a coordinate system.

Aerial photography and orthophoto mosaic- an aerial photo is an image (once a photograph, now a digital image) of the ground taken from an airplane, helicopter, or radio-controlled aircraft at a given altitude. Aerial images are presented as an orthophoto mosaic that is an alternative to a map. These images are higher in resolution (decimeter) than satellite images, proving useful for those who want more details of the terrain such as crop conditions or land use. In addition, modern digital aerial photography is georeferenced—that is, each point has geographical coordinates, whereas satellite imagery requires geo-referencing to be geographically accurate and compatible with other geographical data.

Laser Scanning, or Light Detection and Ranging (LiDAR)- is an active airborne sensor using a set of laser beams to measure distance from an aircraft to features on the ground. Airplanes and helicopters can be used for laser scanning. The data from laser scanning are three-dimensional at very high accuracy, and they also allow ground elevation under the tree canopy to be measured. The elevation accuracy of laser scanning data is much better than

aerial photography, which makes laser scanning useful for accurate topographic mapping where elevation is critical. The data can also be used to measure forest attributes such as the height and density of trees and thus the volume (aboveground biomass) of the forest.

Information Management Technologies: Making Sense of the Data

The raw data collected above are fairly useless without analytical tools, both human and inanimate:

Spatial modeling (among other models)- closely related to spatial analysis or statistics, models are an attempt to simulate real-world conditions and explore systems using their geographic, geometric, or topological properties. GIS (which can also perform analysis), among other ICTs, has increased opportunities to create models that predict occurrences like yield growth and ecosystem degradation.

Data mining- is the extraction of stories or patterns from large amounts of data. Data mining can find four major patterns: clustering (discovering groups), classification (forming a structure), regression (finding a function), and associations (finding relationships). These analyses help to make sense of agricultural data collected by remote sensors.

Data mediation- is the process of taking many different data sets to produce a single, coherent set of information. Data mediation software organizes different types of data (such as hourly versus daily) and synthesizes different approaches to classification (for example, the use of different classification vocabulary), helping to mediate differences between data sources—particularly those on the Internet.

Dissemination Tools: Getting the Results to the Stakeholders

After analysis, the results must reach those who need to react to the findings, using tools like:

Short Message Services(SMS)- text options that allow interaction between fixed-line and mobile phones.

Radio- transmission of information through electromagnetic waves with low frequencies.

WiFi- wireless local area network that allows various devices to connect to the Internet remotely.

Knowledge management system- digital or electronic system that provides relevant information as it is requested.

ICT Tools for Agricultural Development

ICT tools are continuously improving the efficiency of agricultural developments throughout the world. Data collection and monitoring and evaluation (M&E) are a vital part of development work, as the results determine where public services are most needed, and what approaches prove effective. In this regard, ICT tools such as mobile applications are fast taking over traditional methods of collecting and using information and the results are impressive.

ICT and Agricultural Innovation Systems

As ICT tools have developed and become more pervasive, they have become more relevant in agricultural innovation systems. The most pertinent developments for research, extension, and e-learning are reviewed briefly below.

First and foremost, the increased pervasiveness of telecommunication networks has enabled ICT to reach rural areas. Technologies that have long been applicable to poor agricultural communities have not been effective simply because they are difficult to get into the hands of rural users. Expanded telecommunications networks have increased the speed, reliability, and accuracy of information exchange through text, voice, and applications between farmers and other stakeholders. Low-bandwidth networks have also started to trickle into rural areas in developing countries, creating opportunities for farmers to connect with extension workers, agribusiness, researchers, and each other. For example, telecommunications networks have facilitated e-learning by liberating it from the classroom and from the need for the user to invest in anything other than a mobile phone. Power lines and power sources critical for the regular use of and upkeep of ICTs also continue to expand.

Second, cloud computing services have immense potential to improve agricultural innovation systems. The advantage of cloud computing is that it offers pooled and elastic resources on demand over the Internet (Porcari 2009). More specifically, cloud computing has been described as “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Mell and Grance 2009). Over the past few years, these services have created opportunities for data sharing initiatives that were once prohibitively expensive for most institutions to explore, let alone students conducting master’s or doctoral research. They have also eased the data collection and aggregation process, which is critical for research, extension, and education.

For example, a website such as Amazon Web Services can be used to acquire a Windows or Linux server by specifying how much processor, bandwidth, and storage capacity are needed. The required resource is made available immediately over the Internet, and the cost is based on how long the server is used. Cloud computing’s elasticity and variable capacity make it possible to process very large datasets, which can also be shared with anybody with adequate connectivity.

Third, the movement toward open access and public involvement through online or mobile tools also favors agricultural innovation, not only in research institutions but more broadly among all participants in an innovation system. Governments, organizations, and even the private sector are sharing data and reports with the public and one another through ICT. As ICT has alleviated the difficulties inherent in interactions among people in dispersed locations, knowledge sharing and multi-stakeholder engagement are widely acknowledged to have increased.

Research can involve more expert opinion and diversity. Advisory services can tap a much wider range of current expertise and provide advice in a much more targeted way to those who need it. With Internet access, e-learning can occur even in the absence of a formal distance education program, and web platforms such as agropedia make it much easier to develop and transmit content for e-learning programs.

In addition, new forms of knowledge brokering have been made possible through ICT. Knowledge brokering has always been an integral part of agricultural innovation systems. The creation and passing of information between farmers and extension agents, farmers and researchers, and researchers and extension agencies, among others, is critical to innovation and increased productivity through adoption of better farming practices and technologies. Knowledge brokering is becoming a specialization—sometimes a profitable one.

Mobile Technologies in Agriculture

Agricultural information is a key component in improving smallholder agricultural production and linking increased production to remunerative markets, thus leading to improved rural livelihoods, food security and national economies. Improvement of agricultural productivity will be realised when farmers are linked to market information. However, one major problem in many rural areas is that farmers and small entrepreneurs generally have no way of knowing the prices before they travel to the market due to poor communication facilities. They often have to rely on middlemen who take advantage of this ignorance. Accurate and timely market information, particularly of perishable items, can significantly reduce transaction and travel costs. There have been quite a few studies that explored how mobile phones impact livelihoods of farmers (Rashid and Elder, 2009). Correspondingly, a positive view that mobile phones offer good value for money appears to support the uptake of mobile phone applications. The importance of knowledge and information sharing in research for development (R4D) settings has been firmly established through research [7].



The rise of the mobile phone has been one of the most stunning changes in the developing world over the past decade. The increasing ubiquity of mobiles in developing countries presents both opportunities and challenges, especially for critical sectors such as agriculture. Like other technologies before it, the mobile phone is likely to be the subject of inflated expectations and hopes.

To caution against the hype, this module also explores barriers to using mobile phones to benefit agriculture and provides recommendations for practitioners seeking to use the mobile platform to improve farmers' livelihoods.

The proliferation of mobile phones across the globe has impinged on agriculture in various ways. Mobiles are being used to help raise farmers' incomes, making agricultural marketing more efficient, lowering information costs, reducing transport costs, and providing a platform to deliver services and innovate. Whether the potential of these trends can be realized more widely, especially in rural areas and in an equitable way, is uncertain. Every aspect of the technology is changing rapidly; the public sector, private sector, and private citizens are constantly experimenting with new applications for it; and governments are grappling with any number of strategies to ease the digital divide. This section summarizes what is known so far about the benefits, challenges and enabling factors associated with mobile phones in relation to several aspects of agricultural livelihoods.

The following are some of the known benefits of mobile phones in agriculture:

- Helping Farmers Raise Their Incomes;
- Making Agricultural Marketing More Efficient;
- Lowering the Costs of Information;
- A Platform for Service Delivery and Innovation;

Helping Farmers Raise Their Incomes

In some instances, access to mobile phones has been associated with increased agricultural income. A World Bank study conducted in the Philippines found strong evidence that purchasing a mobile phone is associated with higher growth rates of incomes, in the range of 11–17 percent, as measured through consumption behavior (Labonne and Chase 2009). One reason for this finding is that farmers equipped with information have a stronger bargaining position within existing trade relationships, in addition to being able to seek out other markets. A study of farmers who purchased mobile phones in Morocco found that average income increased by nearly 21 percent (Ilahiane 2007).

Mobile phones seem to influence the commercialization of farm products. Subsistence farming is notoriously tenuous, but smallholder farmers, lacking a social safety net, are often highly risk averse and therefore not very market oriented. A study from Uganda found that market participation rose with mobile phone access (Muto and Yamano 2009). Although better market access can be a powerful means of alleviating poverty, the study found that market participation still depended on what producers had to sell: Perishable bananas were more likely to be sold commercially than less-perishable maize.

Mobile phones can serve as the backbone for early warning systems to mitigate agricultural risks and safeguard agricultural incomes. In Turkey, local weather forecasts transmitted through SMS provided very timely warnings of impending frosts or conditions that favored pests.

Making Agricultural Marketing More Efficient

At a fundamental level, markets are about distributing information. They do so through prices, which serve as a unifying signal to participants to allow for the coordination of dispersed producers and consumers. Underlying this powerful mechanism, though, is the assumption that everyone knows the market prices for commodities, which is not the case in much of the developing world. Farmers have little information about market prices in urban areas of their own countries, let alone internationally. The result of this information asymmetry is price dispersion—the same goods sell for widely different prices in markets merely a few kilometers apart.

Mobile phones, in addition to other ICT, can overcome this problem by informing both producers and consumers of the prices offered for agricultural products in various locations. A number of studies have shown that when mobiles are introduced to farming communities that previously lacked any form of connectivity, prices unify as farmers learn where they can sell for a better price.

Lowering the Costs of Information

The most obvious and cross-cutting way that mobile phones can improve agriculture is by improving access to information and making it less costly to obtain. In many rural areas, the arrival of mobile coverage is a radical change in the nature of the information ecosystem. Although simply having more information is not sufficient to make advantageous decisions (other resources may be needed to implement them), it is a necessary step toward access to knowledge.

Transaction costs are present throughout agricultural value chains, from initial decisions about whether and what to plant, to all of the operations during the growing cycle, harvesting, postharvest and processing operations, and selling (to intermediaries, consumers, processors, exporters). These costs can account for a large share of the cost of a farm enterprise.

Mobile phones may help users to substitute phone calls for travel. Where safety standards are minimal, roads are in disrepair, and distances are great, substituting phone calls for travel reduces farmers' time and cost burdens. Time savings are important for agricultural households, because many crops have extremely time-sensitive and labor-intensive production cycles. Farmers who use mobiles can also save on transport costs (Overa 2006)—an effect that is stronger the more rural the area (Muto and Yamano 2009).

Transportation cannot be avoided entirely: Crops need to get to customers. Although mobiles can inform farmers where they should travel to market their crops, evidence suggests that the wealthy maintain an advantage in their ability to make use of this information (Fafchamps and Hill 2004). In combination with improved rural roads, ICT will encourage larger truck-traders to visit harder-to-reach areas, connecting rural and urban regions.

A Platform for Service Delivery and Innovation

The numerous capabilities of mobile phones provide ample opportunities to deliver traditional and innovative services. Traditional agricultural extension agents are increasingly being

outfitted with mobile phones through programs to increase their effectiveness by networking them to knowledge banks. Extension can reach more clients through mobile-based learning platforms—textual or richer platforms, such as video—that provide tips to farmers to improve agricultural skills and knowledge.

Significantly, mobiles are also a platform for user innovation. Mobile money services, now so prominent in countries such as Kenya and the Philippines, originally began as informal mechanisms between family and friends. Software engineers in developing countries are creating locally appropriate applications to be deployed inexpensively. This form of innovation is possible due to the functionality of mobile phones, but capacity needs to be grown and technological barriers, such as incompatible networks, need to be addressed.

C. ICT-Enabled Financial Services- Diversifying Access to Financial Services to Smallholders via ICT

ICTs have now created the potential to deliver a greater diversity of financial products to greater numbers of rural clients than conventional financial service providers have been able to reach. ICTs can also enhance governments' capacity to monitor and evaluate financial services provided to rural clients and design effective financial policies and regulations for the rural sector.

Farmers Require Four Kinds of Financial Services

Credit- farmers require credit in the form of loans, personal loans, salary loans, overdraft facilities, or credit lines, is often used as working capital at the beginning of the growing season to purchase inputs and prepare land. They also need capital to invest in equipment such as tractors or drip irrigation and to harvest, process, market, and transport their produce. It is important to distinguish between short-term loans, which microfinance institutions usually provide, and the long-term financial services required for agricultural and livestock enterprises.

Savings- it may be in the form of current accounts, savings accounts, or fixed or time deposits. Farmers have a significant need for savings, because their income is seasonally tied to the harvest, and for much of the year they rely on savings to smooth consumption.

Transfer and payment- these facilities allow for local and international money transfers, remittances, government transfers, and check clearing.

Insurance- it may be in the form of covering crops and livestock as well as human life and health.

A number of agents in rural areas—such as government departments, commercial banks, microfinance institutions, traders, telecommunications companies, community-based organizations, families, and friends—provide financial services, which can include credit, savings, insurance, transfers, and payments. Even so, tailoring and providing financial services for small-scale farmers remains challenging. Rural clients differ from the typical clients of financial service providers. They are located in remote and often sparsely populated areas, and they rarely possess the sorts of physical or financial assets that financial institutions customarily accept as collateral. Typical rural assets, such as livestock, pose challenges of inventory assessment and management, and collateral substitutes based on warehouse receipts or

returns from future crops are unavailable in many countries. Farmers also have a special need for financial products with a time horizon extending over multiple crop cycles.

This section explores how innovative mechanisms and technologies are used in specific situations in different countries to help rural dwellers—mainly farmers, whose businesses do not readily receive financial support—obtain the financial services listed above from commercial banks and other providers. Some of these technologies are already used in microfinance institutions in urban and peri-urban areas. Important to note, the ICTs discussed in this module are gender neutral; they are enablers and should be used in contexts where both men and women can participate.

Major prerequisites for using ICTs in financial services for agriculture are:

- robust national financial systems
- and the infrastructure that allows electronic financial transactions between institutions and individuals.

Two types of infrastructure and related services facilitate electronic transactions and are vital for extending financial services to rural areas.

The first is ICT infrastructure, such as high-speed Internet and mobile phones, available at affordable prices- this infrastructure is the backbone of electronic financial transactions.

The second is financial infrastructure, which includes national payment systems, credit bureaus, ATM switches, or central platforms for microfinance institutions.

Financial infrastructure enables financial service and technology service providers, as well as other providers vital for the integrity and stability of the financial system, to connect and perform transactions in real time. For example, financial infrastructure makes it possible for customers of one bank to use the ATM of a different bank or conduct a transaction (such as writing checks or wiring money) with customers of a different bank. It also channels financial information (such as the creditworthiness of a new customer) to financial institutions.

These services and infrastructure do not benefit merely one operator or financial service provider; they cater to the entire rural and financial sector. For this reason, their provision is often initially regarded as a task for government, although in reality they can be (and often should be) provided by the private sector alone or in partnership with government.

The supply of financial products and services in rural areas will remain a challenge until financial institutions can reduce the high operating costs associated with catering to rural clients; however, as this module indicates, ICT applications have demonstrated considerable promise in doing so. The next section briefly describes the factors that have proven critical to using ICTs successfully to expand the range of financial services in rural areas.

Trends and Issues

ICT introduces new channels for delivering financial products and services to the rural sector, and it has the potential to reach farmers, intermediaries, entrepreneurs, and rural dwellers more directly than traditional brick-and-mortar bank branches or microfinance offices. These new channels enable financial service providers to offer a larger suite of financial products and services and acquire better financial information, some of which is useful to governments as they oversee, regulate, and develop policy for the agricultural and rural sectors.

Figure 3.4 below illustrates how ICT expands the traditional relationships and service capacities in the rural finance ecosystem

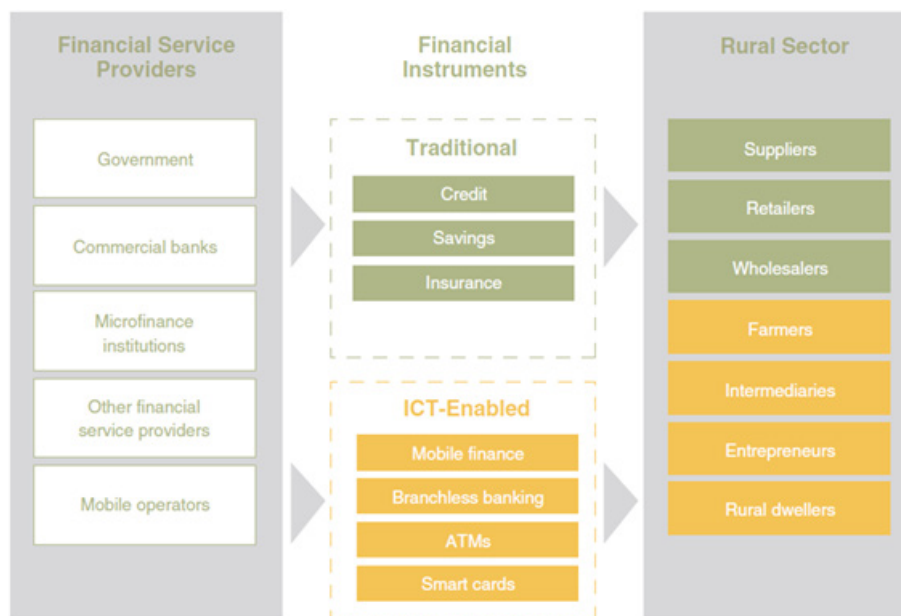


FIGURE 3. 4: ICT and the Rural Finance Ecosystem
(Agroinformatics, http://www.tankonyvtar.hu/en/tartalom/tamop412A/2011_0009_Herdon_Miklos-Agroinformatics/ch15s03.html)

Nonbanks and banks can provide these ICT-enabled financial services for the rural sector:

Mobile financial services- given the pervasiveness of mobile phones in developing countries, financial service providers can use them to reach clients in rural areas and provide a broad array of financial products and services, including credit, insurance, payments, and deposits. Financial service providers can tailor financial products offered through mobile phones to rural needs.

Branchless banking- Field agents, equipped with mobile phones or point-of-sale devices, can serve as mobile branches. Agents can provide financial services to smallholders, take deposits, provide financial information, and keep records of clients' creditworthiness. In this way, branchless banking deepens financial inclusion throughout rural areas.

ATMs- Though ATMs are often associated with debit cards or smartcards, ATMs can serve as cash-dispensing machines in tandem with branchless banking, mobile financial services, and other ICT-enabled financial products. The availability of ATMs in rural areas can place

cash-exchange points within reach.

Smartcards- Though not entirely in the category of ICT, smartcards (or stored-value cards) are an alternate means of providing services when mobile financial services are not readily available. Pre-paid cards, debit cards, or credit cards provide payment and credit facilities to rural clients. Stored-value cards have historically assumed some level of literacy (in particular, the ability to sign for a transaction), but the advent of smartcards that use biometric devices eliminates the challenges associated with literacy barriers. Financial services rely on the availability of underlying financial and ICT infrastructure, such as payment systems, credit bureaus, central ATM switches, central financial platforms, mobile telephony, mobile data services, and Internet in rural areas. Governments have to work with the private sector to ensure that the underlying infrastructure is in place and extended to rural areas.

Accessing Markets and Value Chains

ICT Strengthening Agricultural Marketing

One of the best definitions of marketing is that “marketing involves finding out what your customer wants and supplying it at a profit.” Probed more deeply, this deceptively simple sentence manages to encompass most facets of marketing. It is also a convenient structure around which to explain the expanding role of ICT in strengthening agricultural marketing.

The phrase “finding out what your customer wants” emphasizes the role of communications in agricultural marketing. It encompasses two kinds of information:

- The immediate information required on the market’s demand for specific volumes and quality of agricultural products and,
- The longer-term information on market trends (referred to here as “market intelligence”) required to make future plans for the farm. ICTs, especially mobile phones, facilitate the provision of both types of information. ICTs are used for real-time market research to obtain current information and help users gradually accumulate market knowledge and insight.

“Supply” emphasizes the critical role of transport and logistics in moving products efficiently and effectively from rural production areas to consumption points, which increasingly are located in distant urban markets. The management of supply chains—the aggregation of product, organization of transport, and consolidation of loads—is increasingly improving through the use of ICTs.

Mobile Phone as a Marketing Tool

Although the mobile phone’s main purpose among the public is for social interaction, it is proving to be a powerful marketing tool. Around 60–70 percent of calls are made to family and friends; business calls typically constitute 5–10 percent of calls. Learning to exploit the economic benefits of the mobile phone is a skill that takes some time to develop (see the

evidence from Malaysia later in this section). Younger users are typically better able to exploit the mobile phone's business advantages.

A building body of knowledge indicates that phones, especially mobile phones, have a positive impact on agricultural incomes. The evidence suggests that farmers use mobile phones to tap into a wider range of knowledge and information than they could access previously. Farmers build up a network of contacts and draw on this wider experience and expertise to obtain critical information more rapidly. Essentially the mobile phone, its special applications, and the Internet (although to a lesser extent currently) are becoming management tools for farmers, specifically in relation to marketing.

Greater access to information and buyers steadily adds to farmers' market knowledge and gives them greater confidence to diversify into higher-value (often perishable) products. The additional knowledge translates into a more accurate understanding of demand and an enhanced ability to control production and manage supply chains. Farmers' behavior is changing, and their farming is becoming more commercial. Trends emerging around the use of mobile phones include:

- Farmers deal directly with wholesalers or larger-scale intermediaries rather than small-scale intermediaries;
- Farmers conduct market searches over a wider number of markets; and
- Farmers develop a broader network of contacts than their peers who do not own mobile phones.

Greater access to information seems to help farmers make better decisions around:

Transportation and logistics- Farmers begin to leverage economies of scale. They can organize and coordinate among themselves and (larger-scale) truckers to consolidate volume. Greater coordination also occurs around the timing of aggregation, collection, and volumes. Larger volumes can lower costs and enable farmers to realize higher prices.

Price and location- An ability to compare prices increases farmers' power to negotiate with traders. It also enhances farmers' ability to change the time and place of marketing to capture a better price.

Supply and demand- Farmers gain greater control over their production and product sales by finding new sources of demand, improve their ability to adjust supply and quality to market conditions, and learn about quality, grades, and product presentation.

Diversification of their product base- Over the longer term, a better understanding of market demand and consumer trends helps farmers diversify into higher-value crops and capture greater value.

Access to inputs- Farmers can make more informed decisions about which inputs are better or cheaper to buy and when and where to best obtain them.

Harnessing ICT for Market Research

Multiple and complex dynamics operate around market demand. Consumer demand changes constantly. Demand for specific products fluctuates daily and weekly; longer-term trends in consumer demand vary as well. Marketing channels continuously evolve. The rate of change in consumer demand and marketing channels is accelerating. Ultimately, the farming community will be better off if it can align production more closely to market changes and opportunities.

To become adept at pairing production with opportunities, farmers and others along the value chain need to become better at acquiring market information that is immediately useful and at acquiring longer-term knowledge related to markets. This topic note is organized around these two needs.

Market Information, Intelligence, and Knowledge

Immediate market information is used largely to sell existing crop and livestock products in ways that maximize their profitability, mainly by creating a better understanding of short-term fluctuations in pricing and demand. Most often, short-term information improves price negotiation, but it can also influence the timing of sales and the selection of the market. This kind of information tends to change rapidly, and its timeliness and accuracy is of great importance.

It is longer-term market information, referred to here as “market intelligence,” that affects farmers’ longer-term decisions. Examples of these decisions include the choice of product to produce, the choice of marketing channel to use, and other strategic decisions aimed at maximizing profits. To be made well, these kinds of decisions require an understanding of competing suppliers, buyers’ needs, product specifications, market trends, and other key issues for specific products. Generally, these decisions also build on the aggregate knowledge created through the acquisition of short-term market information over a period of time. The key development challenge lies in assembling and disseminating this information in a timely manner, not just to traders or larger-scale farmers but also to smallholders so that they can make more sensible management decisions and increase their profitability.

The main goal of increasing access to market information is to empower farmers to take greater control of marketing their production and orienting their production to identified market opportunities. A deeper understanding of short-term and long-term market dynamics should, on balance, enable farmers to become more commercially savvy and profitable.

In essence, the ability to conduct market research—to gather both short- and longer-term information—will increasingly become part of the mix of farming skills. In most situations, market information is fragmented, anecdotal, outdated, inconsistent, and incomplete, although the situation differs by product. For example, markets for staple cereals, which are often subject to price controls, move relatively slowly. Information about these markets is more widely known. However, for products that are more perishable or for which consumer demand

is shifting, the market situation is far more opaque.

The primary role of government in promoting the acquisition of immediate information through ICTs is to focus on the overarching importance of maximizing mobile phone coverage while improving access to the technology for the rural poor. An equally important role for government is to support producers in using the technology to become more commercially astute and better attuned to changing markets for agricultural products. The overall aim is to strengthen farmers' position in their day-to-day trading and, over time, enable them to focus production on satisfying consumers' and buyers' demands and to develop skills in market servicing (the capacity to develop relationships with stakeholders in the next stage of the value chain).

Harnessing ICT for Access to and Delivery of Inputs

Farmers' yields deviate from potential yields for a variety of reasons: poor climate or weather may play a part, along with other factors such as socioeconomic status, physical infrastructure, institutional and government policies, or poor access to farming technology or finance. The benefits of narrowing the yield gap include increased productivity and profits. These issues—covered elsewhere in this sourcebook—remain a central challenge in improving farming efficiency. Why don't farmers use inputs and intensify their production more? The response to this question often is limited to farmers' lack of knowledge about technology, its affordability, and farmers' access to working capital.

Yet farmers may also lack information on how to get inputs. Farmers can be unsure when inputs are available, particularly when the government distributes subsidized inputs. ICT can play a significant role in enhancing farmers ability of buying inputs at the right time for the right price.

Case Studies/Best Practices in eAgriculture

In this section an example of four best practices in ICT use in the agriculture sector have been presented with the aim to give learners a broader spectrum of the application of ICT tools as well as inspire them to develop innovative local technological solutions for local challenges.

TIPCEE's ICT Applications Bring Ghanaian Smallholders into Export Supply Chains

Type of eAgriculture Application

USAID's Trade and Investment Program for Competitive Export Economy (TIPCEE) in Ghana was innovative in its use of ICTs to enable fruit and vegetable exporters to become sufficiently competitive to link with international value chains. The project used barcodes, GPS, and geographical information system (GIS) to ensure that produce could be traced to the smallholders who grew it—a major requirement to participate in the target export markets[9].

Application Description

The TIPCEE project used GIS and barcode applications with GPS readers, barcode scanners, a wireless mobile network, and networked computers to address the traceability problem. GPS readers communicate with global positioning satellites to indicate the exact location of a place on the earth's surface through latitude and longitude coordinates. These coordinates can be collected from the boundaries of a particular farm and fed into a GIS application on a computer, which can map the location of the farm, often with great precision.

Once a farm is mapped electronically, a product from that farm can be traced back easily to the source if the product is marked with the coordinate information, which can be done with barcodes but is typically done by physically marking the items. The advantage of barcodes is that, once assigned, they can be scanned at points along the supply chain to track not only the origin but the path of goods from the farm to the end consumer. In this way, GIS maps can, in conjunction with barcodes, ensure traceability.

Zambian Farmers Buy Subsidized Inputs via Mobile Phone

Type of eAgriculture Application

In Zambia, an electronic voucher (e-voucher) system is being piloted by the United Nations World Food Program (WFP), CARE, and the local Conservation Farming Unit (CFU). With the help of Mobile Transactions (a company specializing in low-cost payment and financial transaction services) (<http://www.mtzi.net/>), the e-voucher system empowers smallholders to obtain subsidized inputs from private firms (giving the firms, in turn, an incentive to expand and improve their business).

Application Description

An e-voucher is redeemed in the following steps:

On receipt of the e-voucher, which resembles a prepaid mobile phone card, the farmer goes to a registered agro dealer. The farmer buys inputs using the voucher and the amount of top-up cash required to complete the purchase.

The farmer scratches the first foil to reveal a PIN. The agro dealer uses the PIN to validate the authenticity of the farmer's voucher and certify receipt of the top-up payment. Upon validation, the redeemable cash value of the scratch card is automatically credited to the supplier's transaction account from the master "subsidy account."

Upon delivery (which is either immediate in the case of an agro dealer or later if the buyer purchases from an agent), the farmer scratches the second PIN to confirm delivery and complete the final authorization, which allows the agro dealer or agent to receive final payment from the master subsidy account.

Under the government's Fertiliser Support Programme (FSP), small-scale farmers had difficulty accessing inputs owing to delays in input distribution and poor monitoring of the program's fertilizer distribution.¹⁴ The mobile transaction system enables electronic monitoring of the e-voucher system, documenting which vouchers have been redeemed, where, and for which products, thereby improving the efficiency and effectiveness of the input subsidies. Because farmers are registered with the system, they can be identified more effectively for specific training programs with input- and productivity-enhancing components. Moreover, the e-voucher system supports private agribusinesses by making them the direct source for inputs; as more private input dealers choose to participate, competition may increase.

Innovative E-Learning for Farmers through Collaboration and Multi-Modal Outreach

Type of eAgriculture Application

The apparent limited availability of digital content relating to agricultural extension reduces the opportunity to build sustainable, digitally mediated services that bring new benefits to farmers and increase the reach of extension personnel (for example, see Balaji 2009). This gap could be overcome by developing a content aggregation system that receives and provides information in multiple modes, especially through the Internet and voice/text messaging on mobile phones.

Such information could be generated using standard validation procedures in research and education or captured from transactions (such as query response services involving farmers and experts). The same arrangement could provide additional training support to field-based stakeholders in agriculture, especially farmers. The core principle here is multi-modality in access to information and training/learning support services [10].

Application Description

A key initiative under the World Bank-funded National Agricultural Innovation Project in India is the Consortium for Agricultural Knowledge Management, which has been active since 2008. The initiative is built around an advanced online content aggregation system called agropedia (<http://agropedia.net>), which delivers and exchanges information through a web portal and mobile phone networks accessible to phones with limited or no data capability. Agropedia also provides a subsidiary platform to support online learning for agricultural extension (<http://www.agrilore.org>).

Agropedia was designed to overcome the paucity of useful agricultural extension information in the web space. Online discussions can be set up to support queries or validation. The platform incorporates Web 2.0 elements such as wikis, blogs, and commentary spaces and receives material in digital formats including text, still images, audio, and video. A highly

targeted search engine allows users to search for content in multiple Indian languages, overcoming a serious challenge in using ICTs for development. Agropedia is already linked to the principal website of the Indian Council of Agricultural Research (<http://www.icar.org.in>).

Agricultural extension workers can use the agropedia platform to create their own groups of contact farmers or peers, facilitating e-learning. These groups can be sent timed SMS/text messages and voice messages, enabling specific interest groups to receive specific messages and not broadcasts. A farmer or a practitioner in the field can raise a query via voice or text. A virtual call center built into agropedia receives the query and passes it to appropriate extension workers and experts. In this way, trust and/or interest-based messaging networks can be formed and sustained.

Agropedia is an example of how a highly integrated platform can use multiple approaches to connect a spectrum of stakeholders, including research experts validating information, extension personnel in farm research stations and in the field, and farmers. Field-based producers do not need computers to connect to experts and extension personnel. Farmers with advanced practical knowledge and skills are in a position to share their tips and messages with a much wider community and can participate in discussions related to validation of particular pieces of information.

Agropedia has the equivalent of about 10,000 pages of material on 10 important crops in four languages and has close to 2,000 registered expert users. During two cultivation seasons in 2009–10, the consortium organized mobile phone contacts with about 27,000 farmers in four language regions and conducted 2.2 million SMS/voice transactions through 687 specific messages. Analysis revealed that farmers in general prefer voice as the transaction medium and that the preferred length of voice messages is about 36 seconds maximum.

The consortium is continuing into its second phase. An analysis of costs and efforts in the first phase (January 2009 to September 2010) revealed that university-based extension personnel could participate in the second phase without requiring additional staff. Since mobile phone and platform-hosting costs are low in India compared to the rest of the world, the analysis concluded that the effort can be mainstreamed as a regular activity in a typical agricultural university. The serious challenge is to strengthen ICT capacity among specialists and personnel at all levels, ranging from researchers to field-level extension workers.

Kenya's DrumNet Links Farmers, Markets, and Financial Service Providers

Type of eAgriculture Application

DrumNet is a project of PRIDE AFRICA, a nonprofit that has promoted the spread of microfinance across the continent since 1988. Created in Kenya in 2002, DrumNet was designed to provide market, information, and financial services to smallholders, and it has evolved a sophisticated technology platform to deliver these services. The project illustrates that it is possible for a third party to coordinate and link farmers, buyers, financial intermediaries, and operations managers to deliver financing to small farmers, and that ICTs have a vital role in doing so. ICTs such as mobile phones, smartcards, and management information systems facilitate communication between the parties and help to manage the

administrative challenges of tracking large numbers of smallholders, delivering loans cost-effectively, ensuring that funds are properly used, and collecting payments[11].

Application Description

DrumNet provides the ICT platform through which all financial transactions and communications take place. The platform includes mobile phones, SMS, and email to enable the parties to do business. All payments from buyers pass through DrumNet accounts at the bank.

Information is transmitted up and down the supply chain during the crop cycle primarily via SMS. Bidco is informed about the area planted to estimate production and plans accordingly. The processor monitors crop progress and passes on important crop management information to farmers. Input retailers are updated on which products to stock at what time, and producers learn about collection dates and locations long before harvest.

The input retailers, trained in basic record keeping for DrumNet, submit virtual receipts to DrumNet via mobile phone and receive payments into their bank accounts in two-week cycles through the DrumNet system. Equity Bank is shielded from these many small transactions, as it simply opens a single line of credit in DrumNet's Master Account, receiving regular principal and interest payments from DrumNet from this revolving account. DrumNet's management information system provides the internal controls to track and report on compliance throughout the process. It also retains data to establish user and credit ratings.

ICT in Agriculture Trends and Opportunities

Over the years the integration of ICTs in the agricultural sector has brought significant changes or transformations in a sustainable way- enabling access to timely and relevant agricultural information, which enables farmers make informed decisions on farming to increase productivity.

In this section a summary of the evolving trends with regards to the use of ICT in agriculture is presented with the aim to align learners knowledge of ICT and its applications in the very broader and diverse sector- the agricultural sector.

Efforts are gathering pace in strengthening the use of ICT for transforming the agriculture sector. The following are services where ICT have been critically important for enhancing the agriculture sector performance.

Services that need ICT integration:

- Information services and knowledge exchange networks;
- Value chain linkages;
- and Financial services

Information services and knowledge exchange networks can be unpacked into the following items:

- Input information;
- Agronomic information;
- Weather forecasts; and
- Market information

Outcomes:

- Farmers are able to gain access to several choices on inputs;
- Farmers are able to have exposure on sustainable agro practices;
- Farmers are able to increase their productivity;
- Farmers are able to produce crops with high quality;
- Farmers are able to sell their products on high prices; and
- Farmers are able to exchange information with their peers as well as from stakeholders.

Value Chain Linkages can be unpacked into the following items:

- Setting up or Organizing (it could be in the form of associations or any other grouping mechanism) farmers for purchase and sale; and
- Connecting farmers with input providers as well as markets.

Outcomes:

- Farmers are able to purchase inputs for lower prices;
- Farmers are able to have easy access to buyers or markets;
- Risks on product loss are minimized; and
- Farmers are able to have easy access to new products.
- Financial Services can be unpacked into the following items:
- Farmers are able to gain access financial services via mobile banking;
- Farmers are able to gain access to Micro-credit or savings; and
- Farmers are able to gain access to Micro-insurance.
- Reduced risk and transaction costs;
- Farmers are able to have access to credit; and

- Reduced vulnerability to risks and shocks.

Reflective Activities: Essay/Write-up

- Explain how ICT can enhance farmers access to financial services
- Explain how ICT can make conducting market research easier.
- Explain how ICT can streamline access to and delivery of agricultural inputs.
- Discuss how ICT can improve farmers income?

Conclusion

Countries in the global north have been exploiting the transformational power of ICT to great extent. Despite these developments, because of a diversity of factors developing countries are yet to harness the power of ICT in their agricultural system. As can be witnessed from the success story of a number of ICT for agriculture initiatives, the transformative power of ICT is almost limitless, it can enhance productivity, access to financial service, access to and delivery of agricultural inputs, doing market research, and improve farmer's income.

Assessment

1. Clarity and completeness of the essay or write up, learners ability to prepare the write up using owns word as opposed to copying and pasting from the reference sources used as they are.

Unit Summary

Agriculture is an important sector where the majority of rural population in developing countries depend on it. However, the sector faces major challenges of enhancing production in a situation of dwindling natural resources necessary for production. The growing demand for agricultural products, however, also offers opportunities for producers to sustain and improve their livelihoods. ICT plays an important role in addressing these challenges and uplifting the livelihoods of the rural poor.

ICT has immense potential in transforming the agriculture sector. One area of application for ICT in agriculture is improving, through better management, the efficiency and sustainability in using inputs - land, soil nutrients, feed and fodder, water, energy, pesticides, labour and most importantly, information and knowledge[8]. ICT also help reduce the negative effects of pests and disease and enable aversion and mitigation of risks such as from inclement weather, droughts, floods and long term change in climate.

Through innovation, ICTs continue to contribute to improving throughput of farming

systems, increasing the quantity, quality and marketability of outputs (e.g. food, energy and biomaterials), supporting their marketing and enabling their effective and efficient consumption by households and communities and their ultimate recycling.

In this unit a broader range of issues that relate to the use of ICT in agriculture have been discussed- issues covered include the role of ICT in agriculture development; Making ICT Infrastructure, Appliances and Services Accessible and Affordable in Rural Areas; Enhancing Agricultural Productivity with ICT; ICT Powered Agricultural Development; Accessing Markets and Value Chains; Trends in ICT use in Agriculture. Besides a background information about the nature of agriculture in Africa and best practices of ICT use in agriculture have been covered.

Unit Assessment

Instructions

A solid understanding of the diverse set of issues discussed in this unit is critical, in case of doubts learners are advised to read the notions by going back to the specific sections where the ideas have been presented as well as the reference materials recommended.

1. Describe the uptake problems developing countries face with any of the following items:
 - Decision Support Systems (DSS);
 - Management Information Systems (MIS);
 - Internet, Precision Farming, Process Control, Production Models, E- commerce, others.
2. Describe the potential consequences farmers will have to bear by not using ICT- what they are missing Today and will be missing in the near Future.
3. Do you agree or disagree on the prevailing perception that content-focused services innovations tend to respond to local needs within the entertainment, social networking, game and music domains, and why?
4. What does device divergence mean?
5. How ICT can help in increasing productivity?
6. Describe the three major or broad categories where ICT can make a difference in the agriculture sector?
7. Give examples on how dissemination tools can improve the lives of the rural poor.
8. Explain how integrating ICT particularly on how it can be used by farmers in terms of accessing market information, intelligence and knowledge for profit maximization

9. How can ICT be used to enable farmers gain access to inputs at the comfort of their convenience and for the right price?
10. Explain the various possible ways where farmers can use their mobile(feature or smart) as a marketing tool.
11. Explain how ICT can help farmers in connecting them with input providers as well as markets.

Grading Scheme

The course facilitator is required to prepare subjective questions with respect to what is covered in this unit is required. The above questions are included as sample to aid in course module facilitators on how to prepare unit assessment questions, and the unit assessment weight should not exceed 15%.

Answers

The following are items that need to be considered during evaluation. Presentation of contents, organization, clarity, ability to write in one's own words spelling and grammar errors.

Unit Readings and Other Resources

- Innovating Agribusiness, SWOT analysis of the African Agriculture, <http://innovatingagribusiness.com/2012/04/06/swot-analysis-of-the-african-agriculture/>, Date accessed- June 2015.
- A situation analysis of the agriculture in Sub-Saharan Africa, <http://www.shabka.org/2013/06/16/a-situation-analysis-of-the-agriculture-in-sub-saharan-africa/>, Date accessed- June, 2015.
- Overview of ICT in Agriculture: Opportunities, Access, and Cross-Cutting Themes, © World Bank, https://www.ictinagriculture.org/sites/ictinagriculture.org/files/final_Module1.pdf License: [Creative Commons Attribution license \(CC BY 3.0 IGO\)](https://creativecommons.org/licenses/by/3.0/)
- Promoting ICT based agricultural knowledge management to increase production and productivity of smallholder farmers in Ethiopia, UNDP Ethiopia, NO. 3/2012.
- Making ICT Infrastructure, Appliances, and Services More Accessible and Affordable In Rural Areas, http://www.ictinagriculture.org/sites/ictinagriculture.org/files/final_Module2.pdf.
- ICT Statistics Home Page, ICT Facts and Figures 2015, <http://www.itu.int/en/ITU-D/Statistics/Pages/default.aspx>, Date accessed- June 2015.
- Kenneth Francis M., Joy T., Mobile phones in agricultural information delivery for rural development in Eastern Africa: Lessons from Western Uganda <http://outputs.worldagroforestry.org/record/5599/files/MM10320.pdf>.
- Peter B., Ajit M., Enrica M. Porcari, Information and Communication Technologies— Opportunities to Mobilize Agricultural Science for Development, <https://cgspace.cgiar.org/bitstream/handle/10568/653/crop%20science%20article%20final.pdf?sequence=2>
- <http://www.ictinagriculture.org/sourcebook/module-10-ict-applications-agribusiness-supply-chains#tipcee>, Date Accessed- July 2015.
- INNOVATIVE PRACTICE SUMMARY, <http://www.ictinagriculture.org/sourcebook/module-6-icts-enablers-agricultural-innovation-systems#elearning>, Date Accessed- July 2015.
- INNOVATIVE PRACTICE SUMMARY, <http://www.ictinagriculture.org/sourcebook/module-7-broadening-smallholders-access-financial-services#kenya>, Date Accessed- July 2015.

Unit 4. ICT and Healthcare

Unit Introduction

Increasing the efficiency, effectiveness and sustainability of healthcare services or initiatives thereby improving the health and wellbeing of society is an area where ICT is making significant differences. Countries both in the global South and North are harnessing ICT towards improving healthcare services thereby transforming the healthcare system or streamlining healthcare delivery systems. This unit introduces you to ICT-powered healthcare which essentially means the enhancement of healthcare delivery via the use of ICT. You will be introduced to the key drivers of ICT in healthcare, ICT powered health information systems which includes mobile health(mHealth). In order to solidify your understanding or grasp of ICT in healthcare case studies on best practices of ICT in healthcare delivery systems have also been presented.

Unit Objectives

Upon completion of this unit you should be able to:

- Analyse the role that ICT can play in the health sector;
- Outline the foundations of mHealth or mobile technology in healthcare and its impact on the delivery of care in healthcare systems;
- Design, implement, and evaluate appropriate and sustainable ICT components of healthcare projects.
- Analyse the capabilities and limitations of health information systems;
- Demonstrate different ways in which ICT can be better integrated in healthcare delivery systems

Key Terms

Telehealth: is a form of e-Health that uses telecommunications and information technologies to provide healthcare services over distance and/or time, to include diagnosis, treatment, public health, consumer health information, and health professions education.

Telematics: Telematics is the blending of computers and wireless telecommunications technologies, ostensibly with the goal of efficiently conveying information over vast networks to improve a host of business functions or government-related public services.

Telemedicine: a health care provider or their surrogate and a patient where there is a geographic and/or temporal separation.

Telemedicine: a health care provider or their surrogate and a patient where there is a geographic and/or temporal separation.

Electronic Health Record(EHR): EHR is a real-time patient health record with access to evidence-based decision support tools that can be used to aid clinicians in decision-making.

Learning Activities

Activity 1 - ICT and Healthcare in Context

Introduction

Despite much progress over recent decades in healthcare which primarily attributes to the use of ICT, healthcare in both the developed and developing world remains a time of great challenge. By some measures healthcare delivery over recent decades have been good, but there are many challenges in both the medical and financial fronts that need addressing and ICT can make a difference in the process.

Clearly the underinvestment in ICT cannot be attributed to healthcare delivery problems in developing countries healthcare services, nor is it a panacea to address all the issues. However, as with complex service enterprises such as airlines, insurance and banking, the transformation needed cannot take place without significant investment in ICT and the co-requisite business process re-engineering. ICT is the key enabler to a successful transformation which will meet the requirements of all the stakeholders - patients, professionals and taxpayers. However, the urgent need to address the ICT deficit and the potential benefits of new applications cannot be overlooked.

It is evident that there are many challenges in achieving a successful transition to an IT-enabled healthcare system. These challenges include funding the investment, effective process re-engineering, systems implementation, and the healthcare system capacity to absorb and adapt to new ways of operating. The unit sets the stage for learners to translate their ICT knowledge into solving or mitigating healthcare challenges of varied nature.

In an era of modern healthcare, it is essential that learners of this module need to be introduced to the foundations of technology mediate healthcare services, their challenges and the latest trends in the field. This unit will provide you clear insights regarding the associated challenges and opportunities in the integration of ICT in healthcare.

Activity Details

Key Enablers of ICT-enabled Solutions in Healthcare

Given their rising pervasiveness as well as influence, ICT tools are contributing significantly for universal health coverage endeavors of both developing and developed countries. Innovative use of ICT in healthcare is becoming key enablers of achieving and measuring universal health coverage. ICT tools are empowering patients and communities to engage at all levels of the health system, and can be transformative of countries health sector development. ICT tools have the potential to reduce healthcare costs, improve equitable access and quality of services, efficiently link healthcare systems with social protection programs, and increase accountability and sustainability in healthcare delivery.

The following are the key enablers or requirements of ICT-enabled or mediated solutions in Healthcare[1]:

Digital Access Points- ICT-enabled (Web / Mobile) applications and engagement platforms to provide consumers and clinicians multiple access points to health information outside of regular care settings.

Mobile Care Delivery Platforms- Technologies and tools to support mobile / remote care delivery and access to care services (e.g., telehealth, tele-monitoring, etc.), including upload of patient data for screening, monitoring and treatment purposes.

Integrated Ecosystem- Different interfacing technologies and integrated platform to facilitate seamless and consistent exchange of information.

Integrated Workspaces- Efficient and effective workspaces (e.g., desktops, network connectivity, mobile devices) with seamless integration to support day-to-day business operations.

Consistent and Exchangeable Data Structures- Common data structures to facilitate information exchange and fulfill operational health record requirement, including consistent use of standards for data content and exchange.

Secure Communication- Secure clinical data exchange among physicians, practices, hospitals and other healthcare providers (support real-time information exchange / collaboration, and general knowledge sharing).

Reliable Systems- communication network, patient interfaces) to support health service delivery and operations across the network.

Usable, Flexible and Scalable Systems- Flexibility, scalability, ease and speed of adoption of ICT solutions / services.

Reflective Activities: Essay/Write-up

- Pick an African country of your choice and write an essay about its eHealth readiness?
- Discuss the significance of knowledge management systems in healthcare delivery.
- Identify the factors that stand in the way of using ICT in healthcare delivery for countries in the global south.
- Discuss the driving factors for successful implementation of ICT-powered healthcare services.

Conclusion

Though not to the required level, healthcare delivery in developing countries has significantly improved because of ICT. However, healthcare in both the developed and developing world remains a time of great challenge. By some measures healthcare delivery over recent decades have been good, but there are many challenges in both the medical and financial fronts that need addressing and ICT can make a difference in the process.

Assessment

1. Clarity and completeness of the essay or write up, learners ability to prepare the write up using one's own words as opposed to copying and pasting from the reference sources used as they are.

Activity 2 - Health Information Systems

Introduction

Types of Health Information Systems

In this section an overview of the various types of health information systems have been discussed. Out of the various ways of classifying health information systems, health information systems have been presented based on the three levels of classification (Smith 1995) such as operational, tactical and strategic appropriateness of information(or medical records in this particular case).

Clinical and Administrative Health information Systems

Healthcare organizations integrate a variety of clinical and administrative types of information systems. These systems collect, process and distribute patient-centered data to aid in managing and providing care. An understanding of how each of these types of systems works within healthcare organizations is fundamental in learner's ability to think innovative solutions to existing problems or constraints particularly with respect to the context of developing countries.

The following are health information systems that fall under the clinical and administrative classification.

Case Management Information Systems(CMIS)- these systems are designed to identify resources, patterns and variances in care to prevent costly complications related to chronic conditions and enhance the overall outcomes of patients. Once a trend is identified case management systems provide decision support promoting preventive care.

A care plan is a set of care guidelines that outline the course of treatment and the recommended interventions that should be implemented to achieve optimal results. CMIS are especially beneficial for patient populations with a high cost of care and complex health needs such as the elderly or patients with chronic disease conditions.

Case management systems assimilate massive amounts of information obtained over a patient's lifetime by reaching far beyond the walls of the healthcare organization and track care from one medical visit or examination to the next (Simpson & Falk, 1996).

Information collected by case management systems is processed in way that helps to reduce risks, ensures quality, and decreases costs.

Communication Systems- these systems promote the interaction between healthcare providers and patients.

Communication systems (examples mobile phones, call light systems, pagers, e-mail, instant messaging, etc) have historically been separated from other types of health information systems and from one another.

Integrating communication systems with clinical application provides a real-time approach that will facilitate care among the entire healthcare team, patients and their families.

Core Business Systems- these systems are designed mainly to enhance administrative tasks within healthcare organizations

Core Business Systems provide the framework for reimbursement, support of best practices, quality control, and resource allocation.

The following are four common core business systems:

- **Admission, Discharge and Transfer(ADT)**- ADT systems provide the backbone structure for the other types of clinical and business systems (Hassett & Thede, 2003).
- **Financial**- financial systems manage the expenses and revenue for providing healthcare.
- **Acuity**- activity systems monitor the range of patient types within a healthcare organization using specific indicators.
- **Scheduling Systems**- scheduling systems coordinate staff, services, equipment, and allocation of patient beds. They also help to track resources within a facility while managing the frequency and distribution of those resources.
- **Order Entry Systems**- these systems automate physician orders. They provide major safeguards by ensuring that physician orders are legible and complete thereby providing a level of patient safety that was historically missing with paper-based orders.
- **Patient Care Support Systems**- these patient-centered systems focus on collecting data and disseminating information related to direct care.
- Clinical Documentation Systems also known as Clinical Information Systems(CIS) are the most commonly used type of patient care support system within healthcare organizations. They are designed to collect patient data in real time.
- Pharmacy Information Systems have also become a mainstream patient care support system. These systems typically allow pharmacists to order, manage and dispense medications for a facility.
- **Laboratory Information Systems** - these systems report on blood, body fluid and tissue samples along with biological specimens that are collected at the bedside and received in a central laboratory.
- **Radiology Information Systems**- these systems store information related to radiology diagnostic procedures such as schedule and diagnosis result.

Reflective Activities: Essay/Write-up

- Explore the type of technology both existing or emerging that can be used in healthcare information systems.
- Describe how eHealth systems will look like 10 years from now?
- Discuss the various Clinical and Administrative Health Information Systems and their applications or specific use.

Conclusion

There have been several types of health information systems being used by healthcare providers worldwide. Depending on the purpose for which they are designed for they offer varied healthcare services. It would be good for learners to understand the scale and nature of healthcare issues or problems of countries in the global south in order to be able design innovative ICT-based healthcare services tailored to the constraints or circumstances countries are in.

Assessment

1. Clarity and completeness of the essay or write up, learners ability to prepare the write up using one's own words as opposed to copying and pasting from the reference sources used as they are.

Activity 3 - Digital Medical Records and the Application of ICT for Clinical Decision Support Systems and Remote Diagnosis.

Introduction

Electronic Health Records

The concept of a computer based medical record has been given a variety of names over the years[3], the following have been interchangeably used to describe or represent medical records available in digital form .

- Electronic Patient Record(EPR)
- Computerised Patient Record(CPR)
- Computerised Medical Record(CMR).

It is however important to note the following distinction between Electronic Patient Record(EPR) and Electronic Health Record(EHR).

EPR- describes the record of the period care provided mainly by one institution. Typically, this will relate to the healthcare provided to a patient by an acute hospital.

EHR- describes the concept of longitudinal record of patient's and healthcare(from birth to death). It combines both the information about patient contacts with primary healthcare as well as subsets of information associated with the outcomes of periodic care held in the EPRs.

There are various standards being developed such as the EU standard for Electronic HealthCare record (EHCR). However more excitingly there is also the development of an open (i.e. free) standard, called the openEHR[6].

OpenEHR is a set of open specifications for an Electronic Health Record (EHR) architecture – but it is not a software application. Its design purpose is to enable semantic interoperability of health information between, and within, EHR systems – all in a nonproprietary format, avoiding vendor lock-in of data. All clinical knowledge concepts are captured in a structured way - known as archetypes – outside the software. The types of archetypes support the recording required for common clinical activities, with some of the key building block archetypes comprising observations, evaluations, instructions and actions. Data built according to these are stored in an EHR in larger ‘composition’ structures, which have their own archetypes. Compositions are comparable to a document that results from a clinical event e.g. a consultation record or a discharge summary. Archetypes can be simple, such as temperature, blood pressure or diagnosis, or complex, such as capturing the risk to a fetus if the father has a grandmother with Huntingdon’s chorea. The archetypes contain a maximum data set about each clinical concept, including attendant data required such as: protocol, or method of measurement; related events; and context that is required for the clinical data to be interpreted accurately. The creation of archetypes and templates is almost purely a task for clinicians – openEHR archetypes put clinicians in the driver’s seat, enabling them to create the breadth, depth and complexity of the health record to suit their needs for direct healthcare provision. Aggregations of archetypes are combined in openEHR ‘templates’ in order to capture the data-set corresponding to a particular clinical task, such as an ICU discharge summary or antenatal visit record. When clinicians look at templates, the information contained within them inherently makes sense and doesn’t require significant training for interested clinicians to be able to create templates for their own purposes – be it domain, organisation or purpose specific. Templates can be used to build generic forms to represent the approximate layout of the EHR in a practical sense, and these can be used by vendors to contribute to their user interface development.

Clinical Decision Support Systems(DSSs)

“Decision support” is a phrase that has been used around for some time now and is usually linked with AI (Artificial Intelligence). Basically getting the computer to attempt to carry out some of the processing that the user does when converting the data (‘facts’) into information (“clinically relevant”). While the technical abilities to develop DSS’s in healthcare has been possible for well over decades now few have been taken up to any significant extent due to a number of reasons.

Clinical decision support is the brains behind an advanced implementation of electronic health records. EHRs, e-prescribing systems, computerized physician order entry, and medication reconciliation systems all are strengthened by some form of clinical decision support. CDS can help physician reach proper diagnoses, ask the right questions, and perform appropriate tests on the front end of the decision-making process--preventing errors of omission--as well as stop errors of commission on the back end, during treatment and procedures[4]. Clinical Decision Support systems link health observations with health knowledge to influence health choices by clinicians for improved healthcare.

Most people consider a decision support system to offer one of three levels of support[6]:

- Presents the data in a way conducive to cognitive processing by sorting, classifying, flagging etc. Thus facilitating decision making by the user. For example, presenting a list of drugs for asthma rather than just a list of drugs for all conditions.
- Provides the results of some data manipulation. Here the system mimics part of the cognitive process e.g. provides a list of drugs only suitable to treat Asthma in an 8-year-old who has no other illness.
- Provides the results of some data manipulation and carries out some appropriate action. Here the system mimics more of the cognitive process as well as the output processes e.g. system prescribes drug and arranges next appropriate appointment.

The main purpose of modern CDSS is to assist clinicians at the point of care. This means that clinicians interact with a CDSS to help to analyse, and reach a diagnosis based on, patient data[5].

There are two main types of Clinical Decision Support Systems(CDSSs):

- b. Knowledge-based
- c. Non-knowledge-based

A. Knowledge-based CDSSs

Most CDSSs consist of three parts: the knowledge base, an inference engine, and a mechanism to communicate. The knowledge base contains the rules and associations of compiled data which most often take the form of IF-THEN rules. If this was a system for determining drug interactions, then a rule might be that IF drug X is taken AND drug Y is taken THEN alert user. Using another interface, an advanced user could edit the knowledge base to keep it up to date with new drugs. The inference engine combines the rules from the knowledge base with the patient's data. The communication mechanism allows the system to show the results to the user as well as have input into the system.

B. Non-knowledge-based CDSS

CDSSs that do not use a knowledge base use a form of artificial intelligence called machine learning,[9] which allow computers to learn from past experiences and/or find patterns in clinical data. This eliminates the need for writing rules and for expert input. However, since systems based on machine learning cannot explain the reasons for their conclusions (they are so-called "black boxes", because no meaningful information about how they work can be discerned by human inspection), most clinicians do not use them directly for diagnoses, for reliability and accountability reasons.[6][7] Nevertheless, they can be useful as post-diagnostic systems, for suggesting patterns for clinicians to look into in more depth.

Non-knowledge-based CDSSs are further divided into artificial neural networks and genetic algorithms:

Artificial neural networks use nodes and weighted connections between them to analyse the patterns found in patient data to derive associations between symptoms and a diagnosis.

Genetic Algorithms are based on simplified evolutionary processes using directed selection to achieve optimal CDSS results. The selection algorithms evaluate components of random sets of solutions to a problem. The solutions that come out on top are then recombined and mutated and run through the process again. This happens over and over until the proper solution is discovered. They are functionally similar to neural networks in that they are also “black boxes” that attempt to derive knowledge from patient data.

Non-knowledge-based networks often focus on a narrow list of symptoms, such as symptoms for a single disease, as opposed to the knowledge based approach which cover the diagnosis of many different diseases.

Robotics and Simulators

Another important aspect of the information age is to look at medical devices and instruments as “information representations”. For example a robot is not a machine, it is an information system with arms or legs; a CT scanner is not a digital imaging system, it can be seen as an information system with eyes. The importance here is almost everything what Surgeons do is considered as information.

Medical robotics is becoming an ever increasingly important part of surgery. A summary is provided below(an excerpt from issue 2674 of New Scientist magazine, 24 September 2008, page 21) in order to give learners of this module a glimpse of the evolution of healthcare because of the seamless integration of ICT in the healthcare system.

Robot assistant gives surgeons a cutting look:

The surgeon's eyes dart to the left, and instantly a robotic laser shifts position and gets to work on a new section of tissue. No, this is not telekinesis, but a new eye-tracking technology that could soon be giving surgeons a hand during tricky procedures[6]. The device has been integrated into a da Vinci surgical robot - a tool that allows surgeons to perform keyhole procedures by mimicking their hand movements. However, according to a team from the Hamlyn Centre for Robotic Surgery at Imperial College London, surgeons often need more than two hands when it comes to positioning additional instruments such as endoscopes or lasers. Their device uses the surgeon's gaze to direct these tools instead. It shines an infrared LED on each eye, and cameras track the relative movement of the pupil and the “glint” of reflected light on the cornea to calculate where the surgeon is looking. The information is used to move the instrument to a new position on the patient. Since the surgeon will only want to use the feature at certain times in the procedure, the device is activated by a foot pedal.

Simulators are more prevalent in healthcare education. A confluence of recent events has led to increased growth in the use of clinical simulation across the healthcare education continuum. These factors include an increased focus on patient safety, the call for a new training model not based solely on apprenticeship, a desire for standardized educational opportunities that are available on-demand, and a need to practice and hone skills in a controlled environment[7].

Telematics, Telemedicine and eHealth Systems

Telematics is defined as the blending of computers and wireless telecommunications technologies, ostensibly with the goal of efficiently conveying information over vast networks to improve a host of business functions or government-related public services. The most notable example of telematics may be the Internet itself, since it depends on a number of computer networks connected globally through telecommunication backbones[9].

Health Telematics systems are another type of health information systems. Health Telematics is defined as the electronic transfer of complex data from one place to another. Usually the data is video or multimedia. Therefore teleconferencing (having conferences by video link) is also a type of telematics[6]. Telematics is being used increasingly in areas of the developing world where expert resources are scarce or the population density is low.

Telemedicine on the other hand is defined as the use of medical information exchanged from one site to another via electronic communications to improve a patient's clinical health status. Telemedicine includes a growing variety of applications and services using two-way video, email, smart phones, wireless tools and other forms of telecommunications technology[8]. Over the last decades the use of telemedicine has spread rapidly and is now becoming integrated into the ongoing operations of hospitals, specialty departments, home health agencies, private physician offices as well as consumer's homes and workplaces.

What are the services that can be provided by Telemedicine?

Sometimes telemedicine is best understood in terms of the services provided and the mechanisms used to provide those services. Here are some examples:

- **Primary care and specialist referral services** may involve a primary care or allied health professional providing a consultation with a patient or a specialist assisting the primary care physician in rendering a diagnosis. This may involve the use of live interactive video or the use of store and forward transmission of diagnostic images, vital signs and/or video clips along with patient data for later review.
- **Remote patient monitoring**, including home telehealth, uses devices to remotely collect and send data to a home health agency or a remote diagnostic testing facility (RDTF) for interpretation. Such applications might include a specific vital sign, such as blood glucose or heart ECG or a variety of indicators for homebound patients. Such services can be used to supplement the use of visiting nurses.

- **Consumer medical and health information** includes the use of the Internet and wireless devices for consumers to obtain specialized health information and on-line discussion groups to provide peer-to-peer support.
- **Medical education** provides continuing medical education credits for health professionals and special medical education seminars for targeted groups in remote locations. What Delivery Mechanisms can be Used?
- **Networked programs** link tertiary care hospitals and clinics with outlying clinics and community health centers in rural or suburban areas. The links may use dedicated high-speed lines or the Internet for telecommunication links between sites. ATA estimates the number of existing telemedicine networks in the United States at roughly 200 providing connectivity to over 3,000 sites.
- **Point-to-point connections** using private high speed networks are used by hospitals and clinics that deliver services directly or outsource specialty services to independent medical service providers. Such outsourced services include radiology, stroke assessment, mental health and intensive care services.
- **Monitoring center links** are used for cardiac, pulmonary or fetal monitoring, home care and related services that provide care to patients in the home. Often normal land-line or wireless connections are used to communicate directly between the patient and the center although some systems use the Internet.
- **Web-based e-health patient service sites** provide direct consumer outreach and services over the Internet. Under telemedicine, these include those sites that provide direct patient care.

What are the Benefits of Telemedicine?

Telemedicine has been growing rapidly because it offers four fundamental benefits:

1. **Improved Access** – For over 40 years, telemedicine has been used to bring healthcare services to patients in distant locations. Not only does telemedicine improve access to patients but it also allows physicians and health facilities to expand their reach, beyond their own offices. Given the provider shortages throughout the world--in both rural and urban areas--telemedicine has a unique capacity to increase service to millions of new patients.
2. **Cost Efficiencies** – Reducing or containing the cost of healthcare is one of the most important reasons for funding and adopting Telehealth technologies. Telemedicine has been shown to reduce the cost of healthcare and increase efficiency through better management of chronic diseases, shared health professional staffing, reduced travel times, and fewer or shorter hospital stays.
3. **Improved Quality** – Studies have consistently shown that the quality of healthcare services delivered via telemedicine are as good those given in traditional in-person consultations. In some specialties, particularly in mental health and ICU care, telemedicine delivers a superior product, with greater outcomes and patient satisfaction.

4. **Patient Demand** – Consumers want telemedicine. The greatest impact of telemedicine is on the patient, their family and their community. Using telemedicine technologies reduces travel time and related stresses for the patient. Telemedicine services offer patients the access to providers that might not be available otherwise, as well as medical services without the need to travel long distances.

eHealth is defined as the collection, management, use, storage and sharing of healthcare information using Information and Communication Technology (ICT) [10]. This information can include diagnostic results, discharge summaries, immunisation history, medication history and diagnoses, leading to the creation of comprehensive medical records that can be accessed both locally and via the National eHealth Record System.

eHealth facilitates healthcare to reach remote population which could not be serviced by traditional means. The objectives of eHealth differs from the objectives of Electronic Health Record (EHR) systems in that EHR systems aim to improve effectiveness and efficiency of business processes for productivity and profitability whereas improving well-being and health of people (i.e. customer value) are the key objectives of eHealth systems. However the success of eHealth systems is very much dependent on the success of EHR systems. The term eHealth encompasses a range of services or systems that are at the edge of medicine/healthcare and information technology, including:

- Electronic Health Records (HER),
- Clinical Decision Support Systems,
- Telematics,
- Telemedicine,
- Health Knowledge Management,
- mHealth,

Mobile Health (mHealth)

The term mHealth is used to describe healthcare delivery supported by mobile devices. In other words, mHealth encompasses mobile telecommunication and multimedia technologies integrated with principally mobile and wireless health care delivery systems. It is most commonly used in reference to using mobile communication devices in healthcare, such as mobile phones, tablet computers and PDAs. The mHealth field has emerged as a sub-division of eHealth which is a more broader term encompassing the use of the umbrella term information and communication technology (ICT), such as computers, mobile phones, communication networks, etc for healthcare and information services.

mHealth applications include:

- Data collection- for collecting community and clinical health data,
- Healthcare information delivery or dissemination to practitioners, researchers, and patients,
- Real-time monitoring of patient vital signs, and
- Mobile Telemedicine.

mHealth can be used both in developed and developing countries, however in recent years its impact in developing countries is rapidly rising, which could be partly attributed to the rapid rise of mobile phone penetration in countries characterized as low-income nations. This mobile phone use explosion across the developing world is offering developing countries the opportunity to leapfrog other applications and services on both the health and technology fronts.

It would be more vivid to understand mHealth by discussing some of its potential applications using examples like the following.

For instance this is an example of mHealth, a mobile application can be developed that helps the patient to take medication at the right time and allows family, friends and caregivers to aid (if the patient chooses so) by being alerted as to whether the patient has or not taken the medication.

The flow of mobile health information is characterized by portable hardware coupled with software applications and patient data that flows across wireless networks. Mobile health enables clinical access to a variety of major software applications central to patient care and subsequently increases clinicians' reach, mobility, and ease of information access, regardless of location. For example, a clinician might use a mobile device to access a patient electronic health record (EHR), write and transmit prescriptions to a pharmacy, interact with patient treatment plans, communicate public health data, order diagnostic tests, review labs, or access medical references. Data transmission is realized by technologies common in everyday life including blue tooth, cell phone, infra-red, wifi, and wired technologies, all of which operate as part of a network. Mobile devices can be helpful across the health care spectrum-transmitting vital information quickly during an acute public health crisis or being used for on-going needs such as education and training. When utilized for patient care, mobile devices are credited with improving patient safety by eliminating errors commonly associated with paper-based medical records and enhancing the continuity of care. In addition to improved patient outcomes, workflow and administrative efficiencies from the use of mobile devices can produce cost savings for the user or user organization.

Key Challenges of African Countries Healthcare Systems

On all indicators of health, Africa lags behind the rest of the world, and behind poor countries of South-East and South Asia that were behind Africa when measured on these metrics a few decades ago. African governments focused on direct payment, and continue to do so to a large extent, after most countries started to move more towards facilitating health insurance schemes. Infrastructure problems have made it difficult to provide services to many people in more remote areas. Poverty has slowed the emergence of private healthcare initiatives outside of a few cities. The maternal mortality and the mortality rate for children younger than five years are more than double the world average. There are only 2.3 doctors per 1,000 people in Africa, less than one tenth of the figure in Europe and less than half the figure in South-East Asia[12].

Developing countries face steady growth in the prevalence of chronic diseases, along with a continued burden from communicable diseases[13]. ICT-enabled healthcare services particularly mHealth offers promise in responding to both types of disease burdens. Mobile technologies are widely available and can play an important role in healthcare at the regional, community, and individual levels.

eHealth is becoming more relevant to regional needs in Africa by addressing local issues associated with the paucity of medical centres in rural areas. However, there is uncertainty as to whether the current eHealth model will be as effective on a larger scale. The following are key challenges for eHealth in Africa are[14]:

- The complexity of ensuring interoperability and integration of information systems and securing privacy of information,
- Lack of sustainable finance required for large-scale use of mobile phone technology in resource-limited settings,
- Digital divide,
- Inadequacy of ICT infrastructure and services,
- Lack of an enabling policy environment, and
- Underdeveloped Human resource.

Nevertheless, it is clear that eHealth initiatives are urgently required, initiatives involving mobile phones such as m4RH, eMOCHA and Text to Change have shown encouraging results and the potential for scalability. The following are some examples of mHealth initiatives implemented in African countries that involve simple mobile technology mediation or interventions which have shown tremendous potential in saving lives[15].

Mobile Alliance for Maternal Action (MAMA), ensures that health workers and pregnant workers share health information through free SMS and calls for information on antenatal care, delivery services and child care.

SIMpill, a medication management system that detects non-compliance of medication regimes, uses SMS reminders. Results showed 94% compliance for a TB trial and 92% cure rate.

TxtAlert in South Africa supports HIV patients and their healthcare workers on Anti Retroviral

Therapy (ART) compliance. The success has been resounding with missed appointment rates declining from 27% to 4%.

Since 2011, HP in collaboration with Positive Innovation for the Next Generation (PING), the Clinton Health Access Initiative (CHAI), and mobile network provider MASCOM have successfully rolled out a mobile-enabled program that reduced government response times to malaria outbreaks from four weeks to three minutes.

Trends in eHealth

The following are key and rapidly evolving trends in eHealth[16]:

- From Electronic Health Records to Translational Informatics- Computers, mobile phones, and tablets are increasingly used by medical practitioners as decision support aids to exercise their best judgment in the management of patients.
- Medical websites and stand-alone mobile phone-based guidelines developed over the years are helping physicians to rapidly search for answers to their clinical questions while interacting with patients.
- Tracking health and disease trends
- Telehealth and Tele-monitoring diagnosis and management of patients in rural and remote communities,
- mHealth and Social media- facilitating patients to enter their own data to track health progress in real time, and enabling them to connect themselves to related communities of shared health interest for knowledge sharing via social medias such as Facebook, Twitter, Tumblr, microblogs, etc.

Case Studies/Best Practices in eHealth

In this section selected best practices or case studies in eHealth in developing countries that have brought significant impacts in the healthcare delivery are presented with the sole aim of motivating learners to inspire in order to tackle health challenges of the communities they live in by using ICT-mediated solutions. The case studies or best practices described below are available online.

A. Electronic Immunisation Registry and Tracking System in Bangladesh

Type of eHealth Application

A computerised information system designed to register, schedule and track immunisation of children.

Application Description

For every new-born, a schedule of immunisation is created and printed, then given to parents after registration of their baby's birth, attached to the child's birth registration ticket.

Application Purpose

The main overall rational purpose for the computerised immunisation system was to reduce the drop-out rates from vaccination programmes. The specific purposes of the system were to improve the quality of immunisation data (e.g. by elimination of duplicate records), and to provide access to that data for health workers to use in their operational work, and for managers and policy-makers to use for health planning. In 'softer' terms, the individual driving forces behind the project were the consultant-designer who formulated the idea for the system, and the Chief Health Officer of Rajshahi City Corporation. Both wanted to identify effective uses of ICTs in the health area, and to make more effective use of the birth registration information system by building it into a more integrated life event system. One purpose behind this was to try to make birth registration more attractive to parents in Bangladesh: only a minority currently register their child's birth because they see no advantage; adding in the immunisation schedule was intended to help incentivise registration.

Stakeholders

Individual children and their families(beneficiaries),

public health staff,

Managers particularly in the public health department,

International agencies such as WHO and UNICEF.

Impact: Costs and Benefits

The project was developed as one element in the broader birth registration project. No direct funding was provided for it, but the assumed cost would be not more than US\$5,000.

Health workers in all but one of Rajshahi City's 30 wards use the system on a daily basis to plan their immunisation schedules, and a statistical report shows that 84% of the population is now covered by the system. The system's main contribution is in helping in the planning and execution of effective immunisation at an operational level: providing a back-up even if parents forget their child's vaccination dates; guiding health workers towards those who need their doses; and potentially reducing vaccine wastage. In addition, the system's reports can help various levels of decision-making. It helps show individual health workers and their managers how they are performing, and helps them make better and more quantified performance-related decisions. It gives health managers a comparative understanding of different parts of the city; this helps them focus on particular problem areas and also understand the impact of particular targeted promotional campaigns. And it provides a means for some demand forecasting. Paperwork has been reduced, enabling health workers to focus on more productive activities. Bringing a greater number of mothers and young babies into regular contact with health workers is also another benefit the computerised system has brought.

Enablers/Critical Success Factors

High-level of support from the public support,
The computerised system was easy to use,
Meeting its users and stakeholders requirements.

Constraints/Challenges

Coordinating the various stakeholders was difficult,
Integrating the work of different divisions was difficult,
Change resistance.

Computerising a Central Asian Epidemiology Service

Type of eHealth Application

A computerised information system designed for Epidemiology services.

Application Description

The application was the planned introduction of computers into the Epidemiology Service to replace the previously-manual processes of gathering, processing, storing and reporting disease and public health data. The main software was a series of packages for registration and analysis of various specific diseases and public health risks. These created a single common computer-based information system with local, regional and national databases that relied on common data items.

Application Purpose

To be able monitor and analyse current health trends properly, or to make public health decisions in an effective and timely manner.

Stakeholders

Epidemiology service managers

Health specialists

Statistical analysts

Information systems personnel,

External users in various ministries, local authorities, research institutions and international organizations.

Mobile Appliance for Maternal Action(MAMA)

Type of eHealth Application

SMS text and Voice Messaging Based health information system.

Application Description

MAMA works with low-income and at-risk mothers and families to provide vital health information through SMS text messaging and simple voice messages.

Impact

MAMA is essentially a monitoring system for expectant mothers that ensures the health workers, midwives and the pregnant mothers share health information using SMS and prepaid calls. The system, which offers prepaid mobile phone credit, allows expectant women to call or send SMS to health experts for free, for information on antenatal care and delivery services. The expectant mothers are also called for follow-up and care aside from being prompted on antenatal classes and advised on birth plans and childcare, including breastfeeding.

Stakeholders

MAMA is a Public-Private project from the US government (USAID), it involves the following entities:

Johnson & Johnson, mHealth Alliance, and Baby Center.

The Mobile Technology for Community Health (MOTEC)

Type of eHealth Application

It is a suite of mHealth application that encompasses five key functional mHealth areas.

Application Description

The Mobile Technology for Community Health (MOTEC) initiative, focused on improving maternal and child health, uses mobile phones to increase access to and demand for health information and services among rural women, while also providing data on health service delivery and outcomes to the Ghana Health Service.

Application Purpose

The MOTEC Suite provides an integrated combination of:

- Mobile job aids for health workers,
- Systems for electronically capturing medical data,
- Rules-based messaging to patients, caregivers, and administrators,
- Technology for integrating with telecom systems,
- Logistics management tools and systems, and
- Tools for supervision and evaluation.

Further reading about similar initiatives are available in [18], below is a summary of some of the initiatives.

Kenya, known for its leadership in mobile phone money transfer, now has a system which enables residents with a mobile phone to download a locally-developed application that allows them to determine if a doctor or clinic is genuine. By simply sending an SMS, the user is shown up-to-date lists of licensed medical professionals and approved hospitals, starting with those nearest to him or her.

In **Mozambique**, SMS reminders and educational messages sent to HIV positive persons, including HIV positive pregnant women, help to improve HIV treatment adherence and prevention of mother to child transmission of HIV.

In **Nigeria**, the SMART programme strengthens early infant HIV diagnosis services by reducing the turnaround time for test results by more than half. Nearly every district in Nigeria has network coverage for mobile telecommunication, even in remote areas lacking roads and electricity. Using mobile SMS technology and small battery-operated printers, health facilities can receive and print test results without having computers and Internet access.

In **South Africa**, the MAMA SMS service gives support to pregnant women and new mothers through an evidence-based free messaging service that extends the support provided at health facilities. The service provides pregnancy, postnatal and baby care information to women in their preferred local language.

In **Rwanda**, in order to strengthen community-level and facility-based maternal and child health interventions, RapidSMS and mU buzima track pregnant women and newborns, promote early detection of life-threatening emergencies, and facilitate reporting on community-level indicators relevant to Millennium Development Goals 4 and 5.

Reflective Activity: Essay/Write-up

- What is the difference between Electronic Patient Record systems and Electronic Health Record systems?
- Explain the benefits of a mobile Telemedicine system, why its impact in recent years for developing countries such as African countries is rising?
- Explain how ICT-enabled healthcare delivery can enhance healthcare access to underserved people particularly the rural poor.
- Explain the key challenges of African countries healthcare delivery systems.

Conclusion

Despite the challenges, the use of decision support systems in healthcare delivery are rising. The use of clinical decision support systems by healthcare providers is steadily spreading. The use of ICT tools for remote diagnosis is also gaining momentum.

Telemedicine is one of the most commonly used healthcare delivery which has transformed the traditional healthcare delivery model by overcoming distance barrier. This unit has discussed the potential uses of ICT in healthcare in order to enhance learners contribution towards addressing the challenges in the healthcare sector through the design and implementation of ICT-enabled healthcare delivery systems.

Assessment

1. Clarity and completeness of the essay or write up, learners ability to prepare the write up using owns word as opposed to copying and pasting from the reference sources used as they are.

Unit Summary

Over the years ICT has been increasingly important in the professional practices of health practitioners as well as their continual educational development. It is widely recognized that the role of information and communication technology (ICT) continues driving the evolution of healthcare- cutting healthcare costs as well as improving quality of care. In this unit a broader range of issues pertinent to the use of ICT in healthcare have been discussed- issues covered include Key Enablers of ICT-enabled Solutions in Healthcare, Types of Health Information Systems, mHealth, Key Challenges of African Countries Healthcare Systems, Trends in ICT use in healthcare and best practices of ICT use in healthcare have been covered.

Unit Assessment

Instructions

A solid understanding of the diverse set of issues discussed in this unit is critical, in case of doubts learners are advised to read the notions by going back to the specific sections where the ideas have been presented as well as the reference materials recommended.

1. Explain the reasons as to why Clinical Decision Support Systems have not been widely implemented even though efforts to use them dates back to a decade or two.
2. What are the technical challenges and barriers of implementing Clinical Decision Support Systems?
3. Why Telematics is mainly used in developing countries?
4. What are the key challenges to ICT-enabled healthcare tools deployments in African countries?
5. Discuss the key enabling factors for ICT-enabled healthcare solutions
6. What are the main challenges of African countries healthcare systems?
7. How can ICT tools can be integrated into African countries healthcare systems to mitigate the challenges of the healthcare sector?

Grading Scheme

The course facilitator is required to prepare subjective questions with respect to what is covered in this unit is required. The above questions are included as sample to aid in course module facilitators on how to prepare unit assessment questions, and the unit assessment weight should not exceed 15%.

Answers

The following are items that need to be considered during evaluation. Presentation of contents, organization, clarity, ability to write in one's own words spelling and grammar errors.

Unit Readings and Other Resources

- Queensland Health ICT Strategic Roadmap, <https://www.health.qld.gov.au/publications/system-governance/strategic-direction/ict-strategic-roadmap.pdf>.
- Lesson 9 - Administrative and Clinical Health Information Systems, <http://de.scribd.com/doc/55427391/Lesson-9-Administrative-and-Clinical-Health-Information-Systems#scribd>, Date accessed- August, 2015.
- The Electronic Patient/Healthcare Record, <http://www.floppybunny.org/robin/web/virtualclassroom/chap5/s8/epr1.pdf>.
- Connecting the Healthcare Technology Community, <http://www.informationweek.com/healthcare/clinical-information-systems/10-innovative-clinical-decision-support-programs/d/d-id/1101834?>, Date accessed- August 2015.
- Wiki- Clinical Decision Support System, https://en.wikipedia.org/wiki/Clinical_decision_support_system, Date accessed- August, 2015.
- Types of Health Information Systems, <http://www.floppybunny.org/robin/web/virtualclassroom/chap12/s2/systems1.pdf>.
- Simulation in healthcare education: A best evidence practical guide. <http://informahealthcare.com/doi/pdf/10.3109/0142159X.2013.818632>, AMEE Guide No. 82, 2013; 35: e1511–e1530.
- Wiki- American Telemedicine Association, http://www.americantelemed.org/about-telemedicine/what-is-telemedicine#.VctDq_ntmko, Date accessed- August, 2015.
- Telematics Definition,
- <http://searchnetworking.techtarget.com/definition/telematics>, Date accessed- August 2015.
- Introduction to eHealth- Technology Enabled Healthcare, <http://c-learning.com.au/studio/aapm/IntroductionToEHealth/shell.html>, Date accessed- August, 2015.
- Connected Life- The Impact of the Connected Life Over the Next Five Years, http://www.gsma.com/connectedliving/wp-content/uploads/2013/02/GSMA-Connected-Life-PwC_Feb-2013.pdf.
- Kendall H., Key Trends in eHealth to Proper Health Transformation and Education, http://www.ubcmj.com/pdf/ubcmj_5_2_2014_6-9.pdf.
- eGovernment for Development, <http://www.egov4dev.org/health/case/>, Date accessed- August, 2015.
- Mobile health: transforming the face of health service delivery in the African Region, <https://www.who.int/en/blog/2015/03/10/mobile-health-transforming-face-health-service-delivery-african-region>, Date accessed- August, 2015.

Unit 5. ICT and Education

Unit Introduction

Increasing the efficiency, effectiveness, quality and universal accessibility of education is an area in which ICT is currently making significant differences. Countries both in the global South and North are harnessing ICT towards improving their education system thereby transforming the education system or streamlining universal access to education. This unit introduces you to ICT-powered education which essentially means the delivery of education via the use of ICT. You will be introduced to the key drivers of ICT in education. In order to solidify your understanding or grasp of ICT in education case studies on best practices of ICT in education have also been presented.

Unit Objectives

Upon completion of this unit you should be able to:

- Analyse the role you as a learner to play in innovative use of ICT in education in an effort to use ICT for making classroom processes more inclusive and to address multiple learning abilities;
- Devise effective ways of providing teachers with resources and various tools with which they can augment their eLearning content.
- Design, implement, and evaluate appropriate and sustainable ICT components of education projects.
- Demonstrate different ways in which ICT can be better integrated in education; and
- Develop the skills to critically evaluate eLearning systems against best practices, principles and standards.

Key Terms

Online Learning: The term online learning is often used synonymously with eLearning. It is an umbrella term that includes any type of learning accomplished on a computer and usually over the Internet.

eLearning: eLearning (short for electronic learning) is an umbrella term that refers to all types of training, education and instruction that occurs on a digital medium, like a computer or mobile phone.

Mobile Learning: Learning that takes place on a hand-held device, such as a mobile phone, that can take place anytime and anywhere

Interactive Multimedia: Interactive multimedia allows learners to provide input to an online course and receive feedback as a result of the input. The input might consist of a mouse click or drag, gestures, voice commands, touching an input screen, text entry and live interactions with connected participants.

Learning Activities

Activity 1 - Harnessing the Potential of ICT in Education

Introduction

Over the last two decades ICT has increasingly become pivotal particularly in the context of global development goals because of the increasing demand education for all, and the inability of existing educational systems to meet such a demand without support from the ICT.

Information and communication technology (ICT), which include radio and television, besides digital technologies such as computers and the Internet have been touted as potentially powerful enabling tools for educational change and reform. When used appropriately, different ICTs are capable of expanding access to education, strengthen the relevance of education to the increasingly digital workplace, and raise educational quality by, among others, helping make teaching and learning into an engaging, active process connected to real life [1].

However, over the past several decades the experience of introducing different ICTs in the classroom and other educational settings suggests that the full realization of the potential educational benefits of ICTs is not automatic. The effective integration of ICTs into the educational system is a complex, multifaceted process that involves not just technology—indeed, given enough initial capital, getting the technology is the easiest part—but also curriculum and pedagogy, institutional readiness, teacher competencies, and long-term financing, among others.

Activity Details

ICT-Powered Learning Management Systems(LMS)

What is LMS?

A learning management system (LMS) is an application that provides a comprehensive set of tools for educators to manage learning resources, administrative functions, assessments, and grading. There has been an emerging view that because of evolving Web 2.0 applications, students can be better served by an LMS alternative, a toolbox of web resources that might include social bookmarking tools, document sharing applications, social networking sites, timeline tools, and media options available in the cloud. Underlying this approach is the belief that students should become more familiar with today's technology tools because these skills will be useful in the workplace. As a result, some institutions have begun to offer LMS alternatives, and some instructors are using these options to support their students' learning. The framework of an LMS alternative offers users a coordinating hub with a dashboard or other interface that gives easy access to selected web-based tools. LMS assembled in this way provide a "cafeteria" approach that allows students and instructors to select tools according to course and project requirements[2].

LMSs range from systems for managing training and educational records to software for distributing online or blended/hybrid college courses over the Internet with features for online collaboration. Colleges, universities, school districts, and schools use LMSs to deliver online courses and augment on-campus courses. LMSs also act to augment the lessons the teacher is giving in a brick and mortar environment, not just replace them. Corporate training departments use LMSs to deliver online training, as well as to automate record-keeping and employee registration[4].

At its core, a Learning Management System (LMS) is a software application or Web based technology used to plan, implement, and assess a specific learning process. Typically, a learning management system provides an instructor with a way to create and deliver content, monitor student participation, and assess student performance. The LMS enables the learning content to be to be available and/or accessible online thereby allowing students to view and interact with learning materials through a web browser on essentially any computer that has internet access. There are many commercial LMS products available today as well as several open source options from which educators and institutions may choose. The specific features and functions of these systems vary considerably, but certain core functions can be found across all of them. These functions include administration features such as[3]:

- student registration,
- course assignment,
- tracking of test or quiz scores, and
- completion status.

From the student or learner perspective, the LMS provides personalized access to assigned course materials, messaging and notifications, and access to scores and transcripts.

Most Learning Management Systems offer a core role of functionality designed to enable the training experts to manage the training and learning processes throughout their cycle. A good LMS will provide functions which will include:

- A method for assigning and tracking instructor-led and web-based training,
- Management reports to evaluate learning performance,
- A flexible structure that allows different combinations of user groups to be created, and
- An intuitive and user friendly interface for learners.

Components of a LMS

Most LMS solutions have these key features:

- a database of learners,
- creation, publication and management of courseware and calendars,
- management access and approval signoff,
- automatic enrolment and reminders for mandatory courses,
- creation of course rosters, and a registration processes,
- facility for uploading and management of documents containing curricular content,
- delivery of course content over web-based interfaces, most often allowing remote participation by the instructor or pupil,
- communications between trainers and learners, using instant messaging, email and/or discussion forums,
- various methods of assessment and testing,
- built in analytics tools and ability to provide comprehensive reporting,
- manager and administrator access to view progress of learners, analytics, administer courses and approve content, generally controlled through defined permission levels, and
- integration with human resource systems for tracking employment eligibility, compliance needs , performance goals etc.

How does it work?

LMS alternatives span a wide range of tools and functions. One option might be a complex system built in-house at a college or university, designed to perform many of the functions of a traditional LMS while giving access to outside applications. Another might be a mashup of web applications assembled by an individual instructor and hosted from a blog platform or a social networking site. The tools that faculty members select as LMS alternatives are typically free or low cost, easy to learn and use, and robust enough to support students and faculty without suffering from service outages or other glitches. Ideally, the LMS alternative might integrate with applications already in use on campus, via APIs or existing standards. In such a design, students could select from among the proffered applications to complete their assignments[2]

Who Initiated It?

Institutions or individual instructors pursue LMS alternatives when a traditional LMS does not meet their teaching and learning needs. In this sense, any college or university that supports blogging or uses a collaboration tool like Google Docs might be said to be employing an LMS alternative. In fact, LMS alternatives frequently use existing applications as a hub. The GLEAN application at Pepperdine's Graziadio School of Business and Management, for example, is a secure framework that integrates the university's traditional LMS with Web 2.0 applications, allowing students and faculty to access a collection of online media and social networking tools. A program at the University of British Columbia illustrates just how an LMS alternative can fill a gap for the standard LMS. Students in the Global Resource Systems program, who spend a term overseas in a developing country, often find themselves living without sufficiently sophisticated telecommunications infrastructure to accommodate UBC's standard LMS. Instead, a WordPress MultiUser (MU) blog site functions as an online learning center for these students. Instructors submit course content, and students discuss class topics and submit assignments—all within the blog structure, with all student and faculty work on the blogs open to public view. Class presentations, podcasts, and other resources are linked to and from this space, and presentations are posted to SlideShare. The site aggregates resources and serves as a directory for the student work posted in individual blogs while the blog structure allows participation and comments from registered and unregistered contributors, including alumni and students in other countries. This setup allows the participation of those not currently enrolled, something the traditional LMS typically does not easily accommodate.

Why is it significant?

With the phenomenal growth of information, increased student diversity, new learning theories and growing access to the internet, today's teachers are presented with an opportunity to transform the learning process from a traditional transmission model to learner-centered model. In the traditional learning model, students could successfully complete their schooling by memorizing a set of static facts and figures and this knowledge has been used as a foundation for their career. However, the pace of knowledge generation has accelerated to a point where it is estimated that by the year 2020, knowledge will double every 73 days (Appleberry, 2003). This makes the use of ICT-powered LMS in the learning and teaching process a necessity.

Aligning learning requirements with evolving ICT models or paradigms such as cloud computing is a timely issue. ICT tools available in the cloud may offer students advantages for collaboration and content creation. The broad selection of Web 2.0 tools makes it possible for instructors and students to choose the tool that best fits a learning exercise. When students are able to publish their work on the web, it can engage individuals from outside their university or college towards generating informal peer reviews. Such exchanges can provide students with experience in how to weigh the criticism of others.

What are its Limitations?

Using alternatives to the LMS can take time for instructors and students. Teachers must evaluate new tools and match them with suitable assignments, and students must learn new application types. Some web-based applications charge fees for use, while many that are free include advertising. In either case, the locus of control is outside the institution, raising concerns about interruptions of service, the security of data and personal information, and the effect on an institution's reputation that could result from a security breach. Institutions that adopt third-party applications for learning have little or no recourse if those products are poorly maintained, shut down for repairs, or cease to exist. While some applications include privacy settings, these are generally not subject to the institution's authentication protocols. As a result, many instructors return to the LMS for student grading to ensure compliance with applicable regulations. While some web applications use emerging web standards, they are not designed to access the student information system, course reporting, or enrollment information. In addition, any alternative LMS could raise issues about a lack of technical support, a dearth of faculty support, an increasingly fragmented student learning environment, and the absence of a common learning platform.

Attributes of good LMS solutions:

1. **Interoperability and Flexibility**- the extent of support in facilitating movement of learning content in and out of the LMS.
2. **Cost effectiveness**- support for the use of educational resources on the basis of creative common licenses.
3. **Support and Training**- the number of staff required to directly support learners.
4. **Ease of Use**- the degree of effort to use and maintain it.
5. **Scalability**- how increasing learners size is easy or how the systems behaves when increasing users base.
6. **Sustainability**- the availability of resources including budgets to be able continue use LMS tools.

Reflective Activity: Essay/Write-up

- Analyse eLearning systems(Moodle or any other system) with respect to the attributes of good LMS
- What are the differences and similarities between eLearning and mLearning?
- Explain the key challenges of using LMS by a learning institution?
- How can ICT help countries in the global south achieve the goal of universal access to education?

Conclusion

Some eLearning systems such as Moodle are developed for open use where its source code can further be enhanced. Learner can therefore add those good attributes missing in Moodle and make the eLearning tool more complete.

Assessment

1. Clarity and completeness of the essay or write up, learners ability to prepare the write up using owns word as opposed to copying and pasting from the reference sources used as they are.

Activity 2 - ICT the Vehicle for Opening up Educational

Resources

Introduction

Open Educational Resources(OER)

Open Educational Resources (OERs) are any type of educational materials that are in the public domain or introduced with an open license. The nature of these open materials means that anyone can legally and freely copy, use, adapt and re-share them. OERs range from textbooks to curricula, syllabi, lecture notes, assignments, tests, projects, audio, video and animation.

In other words (OER) are any resources available at little or no cost that can be used for teaching, learning, or research. The term can include textbooks, course readings, and other learning content; simulations, games, and other learning applications; syllabi, quizzes, and assessment tools; and virtually any other material that can be used for educational purposes. OER typically refers to electronic resources, including those in multimedia formats, and such materials are generally released under a Creative Commons or similar license that supports open or nearly open use of the content. OER can originate from colleges and universities, libraries, archival organizations, government agencies, commercial organizations such as publishers, or faculty or other individuals who develop educational resources they are willing to share[6]. They are freely accessible, openly licensed documents and media that are useful for teaching, learning, and assessing as well as for research purposes. Although some people consider the use of an open file format to be an essential characteristic of OER, this is not a universally acknowledged requirement[5].

Operations

The term OER generally refers only to digital resources and, as such, tends to focus on usage in online or hybrid learning environments, though electronic content can certainly be used in face-to-face environments as well. Each resource is issued under a license that spells out how it can be used: Some materials may only be used in their original form; in other cases, learning resources can be modified, remixed, and redistributed. OER are typically found in collections or repositories. These can be offerings from a single institution, such as when a college or university makes available online the resources from its courses, or they can be collections of materials gathered from individuals or departments from a wide range of separate institutions. Instructors and individual learners can download OER and use them in formal or informal learning situations, and one of the hallmarks of OER is their flexibility—many are modular in nature, allowing them to be used in novel combinations to suit particular learning activities. Because open resources are so malleable, they can be adapted to keep pace not only with new technologies but also with changes to academic disciplines and teaching methods. Depending on the resource, these updates might be made by the creator or by users of the resource[6].

Initiator

One of the longest-running and highest-profile OER initiatives is the OpenCourseWare project from MIT, which began in 2002 and today features all of the course materials from roughly 2,000 MIT courses. The OpenCourseWare model has been replicated by dozens of colleges and universities around the world, which are putting full course materials online for anyone to use. Having access to an institution's course resources is not intended to be equivalent to taking a course at that institution, but users can take advantage of that access to supplement or direct their own learning. Other OER efforts include Connexions, which was begun at Rice University, and the Open Learning Initiative from Carnegie Mellon, as well as the University of the People and even iTunes. Although OER projects use different models for how they function, all endorse the notion that teaching, learning, and research are improved when educational resources are more open and more accessible[6].

Significance

Educational resources developed in an open environment can be vetted and improved by a broad community of educators, resulting in materials that represent what the educational community sees as most valuable. By providing educators with new access to educational material, open resources have the potential to spur pedagogical innovation, introducing new alternatives for effective teaching. OER have the potential to expose students and instructors to the long tail of content, most of which never finds its way into widespread educational use. Moreover, learning resources that can be modified and reused promote collaboration and participation—two key elements of a Web 2.0 approach to teaching and learning.

The resources required to develop high-quality learning materials and activities for a full complement of courses can be prohibitive for many institutions and instructors. By distributing the costs over a larger number of users, OER brings a greater range of tools within reach of more users. OER can also lower the costs for students to obtain educational content. OER and online or hybrid learning are natural partners in efforts that take advantage of—and prompt—developments in educational technology that facilitate new media, new formats, and new means of distribution[6].

Limitations

Like all educational resources, the quality of OER can be uneven and depends largely on their sources. Some OER are simply ineffective at presenting content in a valuable manner, and not all OER collections have a feedback mechanism by which users can share their evaluations about the quality of a resource. The value of educational resources tends to decrease without periodic updating, and many open resources are not kept current. Even within an OER repository that is operated and sanctioned by a respected institution, individual resources might not be held to the same standard of quality as the institution's other offerings. The flipside of the flexibility of open resources is that many need to be adapted for use in a departmental or institutional context to meet local requirements or needs. Some open resources do not comply with accessibility requirements for users with disabilities.

Whenever content is shared, and especially when it can be modified, questions arise over intellectual property and copyright concerns. In some cases, faculty resistance to opening their resources can be an obstacle.

What are Some Examples of OER Projects?

One of the best examples of OERs is the MIT Open Courseware project, which makes the course materials from nearly all MIT courses free and available online[7].

Another good example is national legislation introduced by the government of Brazil to mandate that all educational materials produced with public funds be open-licensed.

The World Bank has recently launched the Open Knowledge Repository, an online collection of World Bank publications released under Creative Commons licensing. Through the repository, their research and reports are published online for educators, researchers and students around the world. Rather than making their information only available to those who can afford to pay for it, now lecturers from any university to incorporate reports and data from the World Bank into their classes. In addition, anyone with an interest in topics ranging from education reform in Mozambique to Afghanistan's opium economy challenges can now read the World Bank's reports on these topics online.

Concept and Context of the Open Educational Resources (OER) Movement

The concept of 'Openness' is based on the idea that knowledge should be disseminated and shared freely through the Internet for the benefit of society as a whole[8]. The two most important aspects of openness are free availability and as few restrictions as possible on the use of the resource, whether technical, legal or price barriers. Openness exists in different forms and domains and has different meanings in different contexts. For example, in the social domain it is fundamentally motivated by the expected social benefits and by ethical considerations related to freedom to use, contribute and share. Openness in the technical domain is characterized by access to source code and/or access to interoperability standards or the standards process. According to Tuomi (2006) a higher level of openness is

"about the right and ability to modify, repack and add value to the resource. However, most existing initiatives offer the most basic level of openness - "open" means "without cost" but it does not mean "without conditions"."

The definition of 'open' is constantly evolving and varies according to context e.g. sharing software source code, re-(using) content and open access to publications. The following well known initiatives present important steps toward creating, sharing and reusing open source, learning objectives, research outcomes and encouraging and promoting the use of open licenses.

Open Source Initiative <http://www.opensource.org/>: During February 1998, Eric Raymond and Bruce Perens founded OSI, the Open Source Initiative, with the purpose of “managing and promoting the Open Source Definition for the good of the community, specifically through the OSI Certified Open Source Software certification mark and program”. It is dedicated to promoting open source software for which the source code is published. This allows anyone to copy, modify and redistribute the code and its modifications without paying royalties or fees. The process is enabled and guaranteed by Open Source Licenses which ensure that software licenses that are labelled as “open source” conform to existing community norms and expectations.

Open Content Initiative <http://www.opencontent.org/>. Inspired by the success of Open Source Initiative (OSI), David Wiley founded “Open Content Project” in 1998 (Wiley 2003) to popularize the principle of OSI for creating and reusing learning objectives and content. The first content-specific license was created for educational materials and a key fundamental of Wiley’s original license is that any object is freely available for modification, use and redistribution with certain restrictions.

Open Access Initiatives <http://www.pubmedcentral.nih.gov/about/openaccess.html> : The idea of Open Access is that scholarly work should be freely and openly available online with no unnecessary licensing, copyright, or subscription restrictions. Three key initiatives serve as milestones for the open access movement. In December 2001, the Open Society Institute organised a meeting in Budapest and the outcome of this meeting was the Budapest Open Access Initiative (BOAI). The Budapest Initiative announced two strategies for open access the establishment of open access journals and self-archiving by scholars of their work. In April 2003, a meeting at the Howard Hughes Medical Institute in Maryland resulted in the Bethesda Statement on Open Access Publishing - free access to scholarly journals. It provided a working definition of open access publishing and agreed a set of principles that all parties (scholars, research institutions, publishers and librarians) could adopt to ‘promote the rapid and efficient transition to open access publishing’. In October of 2003, a conference at the Max Planck Society in Berlin resulted in the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities. This states that progress should be made by encouraging researchers to publish their work according to open access principles and cultural institutions to provide their resources on the Internet.

Creative Commons <http://creativecommons.org/> - Creative Commons’ first project, in December 2002, was the release of a set of copyright licenses for public use. These machine-readable licenses are designed for websites, scholarship, music, film, photography, literature, courseware, etc and they help people make their creative works available to the public, retain their copyright while licensing them as free for certain uses, on certain conditions. ccLearn, the educational division of Creative Commons, was launched in 2007 and is dedicated to realizing the full potential of the Internet to support open learning. It is expected to further reduce barriers to sharing, remixing and reusing educational resources.

Drivers or enablers and inhibitors of OER

As with any other technology-related initiatives in education, OER is driven by technical, economic, social, policy and legal factors. Some of these factors provide either a favourable environment or a particular handle for bringing about changes and others may hinder a broader uptake of OER initiatives. OLCOS (2007) in OER Roadmap 2012 grouped the drivers/enablers and possible inhibitors according to their assumed short to medium (until around 2009) or longer-term influence (until 2012) as the following:

Drivers/enablers:

- International organisations' promotion and funding available;
- Competition among leading institutions in providing free access to educational resources as a way to attract new students;
- Success of open access initiatives and repository projects;
- Rapid development and wide use of Social Software tools and services and emergence of personal learning environment;
- Licensing open content will become easier as plug-ins for widely used authoring software packages become available.
- Policies emphasize educational innovation and organisational change in educational institutions;
- ICT-based lifelong learning and personalised learning needs;
- Opportunities for co-operation and collaboration between institutions around the world;
- Global competition in Higher Education and decline in student numbers in Europe due to demographic trends;
- Creative Commons licensing is firmly established and is being used increasingly;
- New systems for creating and handling group-based Learning Designs may become more widely used;
- Semantic applications will provide new ways to access knowledge resources.

Inhibitors:

- Growing competition for scarce funding resources;
- Difficulty in finding a balanced approach to open and commercial educational offerings;
- Copyright issues;
- Fears of low recognition for OA(open access) publications, particularly among young researchers;
- Lack of policies for the development and use of repository at institutional level;
- Lack of communication and cooperation between system and tool developers and educators;
- Business models in OER will remain tricky;

- Lack of institutional policies and incentives for educators to excel in OER;
- Models that build on teachers in the creation and sharing of OER will need to invest considerable effort in training and support;
- Creation of educational metadata will remain costly;
- Need more advanced tools and services for educational repository.

Reflective Activity: Essay/Write-up

1. Discuss the key issues of enabling open access for educational resources from ICT perspective
2. What commonalities exist between OER and eLearning?
3. Describe the compelling reasons as to why developing or African countries need to embark on OER initiatives
4. Design or sketch the factors(possibly organize them into phases) diagrammatically that need addressing by a learning institution towards the implementation/deployment of OER
5. What are the key enablers of OER ?
6. Identify the necessary factors that determine a country's or learning institution's readiness to the use of OER
7. Describe any disadvantage that OER may have.

Conclusion

OER movements are gaining momentum worldwide. However, most countries in the global south are yet to be part of the movement. In this unit, a range of issues that surround OER initiatives have been discussed. The impact of factors vary across countries and it would be good for learners to recognize this reality in order to use their ICT knowledge and skills to mitigate the issues with innovative ICT mediated solutions.

Assessment

1. Clarity and completeness of the essay or write up, learners ability to prepare the write up using owns word as opposed to copying and pasting from the reference sources used as they are.

Activity 3 - MOOCs, Creative Commons, ICT-Powered Emerging Trends in Education

Introduction

A. Massive Open and Online Courses (MOOCs)

Open online courses, sometimes called “massive” (MOOCs) due to their high enrolment numbers (McAuley et al. 2010), offer a middle ground for teaching and learning between the highly organised and structured classroom environment and the chaotic open web of fragmented information. In a traditional classroom or online course, learning designers and educators structure the readings, learning resources, lectures and activities of learners. As a result, learning is directed toward clearly articulated goals and outcomes. The educator provides shape and direction to the learning experience by forming groups and providing assessments, assignment focuses or guidelines. Connectivism and Connective Knowledge (CCK08) was the first MOOC, offered both as an open course and in the Certificate in Emerging Technologies for Learning (CETL) at the University of Manitoba. CETL was designed as a Masters-level certificate with three core and three elective courses. CCK08 was the initial core course in the programme. The course syllabus was translated into six different languages. As put forward by McAuley et al. (2010, p. 5):

“A MOOC integrates the connectivity of social networking, the facilitation of an acknowledged expert in a field of study, and a collection of freely accessible online resources. Perhaps most importantly, however, a MOOC builds on the active engagement of several hundred to several thousand ‘students’ who self-organise their participation according to learning goals, prior knowledge and skills, and common interests. Although it may share in some of the conventions of an ordinary course, such as a pre-defined timeline and weekly topics for consideration, a MOOC generally carries no fees, no prerequisites other than Internet access and interest.”

Specifically, MOOCs are:

Massive, involving hundreds and thousands of students. The scale of “massive” is somewhat relative. Early MOOCs had in the range of 2,000 students, but offerings by Coursera and Udacity have exceeded 100,000 registrants. An important benefit of large numbers of students is the opportunity for sub-network formation by participants. For example, in CCK08, students formed sub-networks around language, geographical locations, physical “meet-ups,” technology spaces such as Second Life, and different education segments (primary and secondary, higher education, corporate learning). While the concept of massive raises concerns about isolation and overwhelming student-instructor ratios, at least some students use the size and diversity of networks to personalize their learning through forming sub-networks.

Open, in terms of access. MOOCs, particularly those offered by for-profit firms such as Coursera, are not necessarily openly licensed, but students can access the course content and participate in guest lectures without fees.

Online, exclusively. In some instances, learners arrange physical meetups, but most of the learning activity — content and interactions — occurs online.

Courses. MOOCs have a set start and stop time. Even if MOOC archives are made available after the course, social interactions in forums and blogs occur during the set times of the course offering. While there are some areas of overlap and use of open education resources with MOOCs, the content is somewhat structured and sequenced, even when multiple sources of learning content are used.

MOOC Formats

MOOC models are evolving quickly. In their current configuration, they can be classified as:

- xMOOCs,
- cMOOCs, and
- quasi-MOOCs.

xMOOCs

xMOOCs are offered in a traditional university model such as Stanford (Coursera), MIT (Massachusetts Institute of Technology)/Harvard (edX), and Udacity. This format started in the fall of 2011 with Stanford University's course in Artificial Intelligence (www.ai-class.com/). Coursera and Udacity are for-profit initiatives. In contrast, edX is not for profit. Traditional universities, including many elite American institutions, are the driving force behind this model. The pedagogical model that underpins these courses is one of "teacher as expert" and "learner as knowledge consumer." Learning is primarily a process of the learner duplicating the knowledge structure set by the course designer and the instructor teaching the course. Weekly course topics are addressed through recorded lectures that range from 3 to 30 minutes in length. Udacity, not affiliated with a university, relies on short lectures and interactive activities that rarely exceed five minutes. Coursera, which includes traditional universities as members, offers video lectures that typically range between 15 and 30 minutes. In order to meet the challenges of large numbers of students, assignments are computer-graded in xMOOCs. Direct instructor feedback is not common, except in discussion forums where teaching assistants and the course instructor respond to student questions. Coursera and Udacity encourage participants to form regional meet-ups to connect with other students. As of late 2012, Coursera lists over 2 million students (or "courserians") and over 200 courses.

cMOOCs

cMOOCs are based on a connectivist pedagogical model that views knowledge as a networked state and learning as the process of generating those networks and adding and pruning connections. Of particular importance in cMOOCs is the view of knowledge as generative and the importance of artifact creation as a means of sharing personal knowledge for others to connect to and with. In contrast with xMOOCs, cMOOCs are largely open in terms of the activities that learners can pursue related to the theme, with limited structure and weekly themes. A pre-history of cMOOCs includes smaller open online courses offered by

David Wiley and Alec Couros in 2007 and early 2008 (Downes 2012). Since CCK08, numerous courses have been offered in the distributed cMOOC format. cMOOCs are distributed, and they emphasize, the importance of learner autonomy. As a consequence of increased learner control, numerous tools and technologies are used during the delivery of an open course. Each learner selects the technologies that he or she prefers to use. Course facilitators provide: an infrastructure for content and administrative details (in the form of a wiki or a Web page); a schedule for synchronous sessions involving guest speakers or live discussions; a means of communicating with participants and providing course updates (often handled through email and blogs); and starting points for learners to form connections with each other (a learning management system such as Moodle).

quasi-MOOCs

quasi-MOOCs provide Web-based tutorials as OER, such as those of the Khan Academy and MIT's OpenCourseWare (OCW). These are technically not courses. They consist of OER intended to support learning-specific tasks such as an operation in algebra, or they are treated as asynchronous learning resources that do not offer the social interaction of cMOOCs or the automated grading and tutorial-driven format of xMOOCs. These resources are loosely linked and are not packaged as a course. The Saylor Foundation (www.saylor.org/) has full courses primarily as OER and available for free use by learners. These courses are being accepted for credit at some educational institutions (Carey 2012) and as an open course format using Google Course Builder <http://cb-me102.saylor.org/>

Challenges of MOOCs

Numerous challenges are starting to emerge. In particular, MOOCs have high dropout rates, lack an economic or sustainable model, face challenges of plagiarism, and risk de-skilling the instructors or teachers.

Dropout Rates

MOOCs have poor completion rates in comparison with traditional university courses. Daniel (2012) reports that an MIT course, Circuits and Electronics, only had 7,157 students out of 155,000 complete the course. However, dropouts in MOOCs may be driven by different factors than in traditional courses. Students taking a traditional course have a different level of commitment because of credit seeking, the motivation of paid tuition fees, and the need to take a course to fulfil degree requirements. Together, these factors are a type of "hard commitment" on the part of students. Failure to complete the course has implications for future study. Learners who take a MOOC may do so for a range of reasons beyond credit. The obligation for continuing a course is not driven by responsibility of completion, but for reasons such as personal interest or motivation. To date, studies have not been conducted on the impact of "soft commitment" in MOOCs. For example, participants may be interested in taking only a few of the weekly topics out of an entire course.

It is still possible that students have a sense of personal disappointment in failing to complete a course, but course completion is different in online courses, even though many of the metrics of success (such as concern over dropout rates) are different from those in regular university courses.

Sustainability

MOOCs do not yet have a sustainable revenue model. Developing, delivering and updating online courses is a resource-intensive undertaking. Until a revenue model is established, concerns will exist around the viability of MOOC providers and the MOOC model of learning.

De-skilling the Professoriate

One potential impact of “super professors” from top universities providing recorded lectures to other universities and colleges is the progressive de-skilling of the professoriate (Basu 2012). MOOC providers such as Coursera and Udacity are for-profit organisations backed by venture capital funding. As such, the first mandate of these providers is to their shareholders, not to students or to society.

Cheating and Plagiarism

While MOOCs are often non-credit, cheating and plagiarism is a growing concern for university providers (Young 2012a). These concerns require attention from open course providers in order for MOOCs to be considered for credit or transfer by universities.

The Impact of MOOCs

MOOCs may well be a transitory stage for education. The concerns that MOOCs raise need to be addressed before this course format is accepted broadly. When viewing MOOCs from the perspective of how students interact and how information is created, it becomes apparent that a key aspect of this format is how it mirrors or reflects the structure of the Internet (at least, the cMOOCs). An ecosystem is developing around MOOCs. MOOCs are a platform on which various service offerings are provided. As an example, Twitter’s popularity has resulted in the development of numerous products and services that enrich the experience for users. While Twitter itself was initially a platform for sharing short messages, often from mobile phones, numerous products were developed on the Twitter platform for reading tweets, sharing images and videos, and archiving tweets. This ecosystem improved the value of the Twitter platform. Similarly, MOOCs are today at an early stage, but already there are indications that a similar suite of products and tools will be built on top of existing offerings. Another impact of open online courses is a power shift toward increased equity between educator and learner. Figure 1.2 details how the traditional faculty–content–learner role is increasingly augmented through OER and external experts.

The emerging educator–learner power shift is also reflected in access to learning content, social media and content creation tools reflective of the participatory nature of the Web.

B. Creative Commons and Open Educational Resources

The Internet and digital technologies have transformed how people learn. Educational resources are no longer static and scarce, but adaptable and widely available, allowing educational institutions, teachers, and learners to actively participate in a global exchange of knowledge via Open Educational Resources (OER). Creative Commons provides the legal and technical infrastructure essential to the long-term success of OER, making it possible for educational resources to be widely accessible, adaptable, interoperable, and discoverable[10].

Creative Commons licenses help educators to broaden the impact of their own educational resources, to customize resources made similarly available by others to suit their own curriculum needs and the needs of their students, and to easily search for and find relevant OER. The following are a few examples of the kinds of innovative educational activity that Creative Commons legal and technical tools have enabled:

Creative Commons enables translation of educational resources into different languages. A growing number of creators of educational resources are self-distributing their works openly via the Internet. When educational resources are released under a Creative Commons license permitting adaptations, anyone interested in the subject matter may translate those resources and otherwise customize them for local needs. For example, CC-licensed courses made available by MIT OpenCourseWare have been translated into at least 10 languages, including Spanish, Portuguese, Chinese, French, German, Vietnamese, and Ukrainian.

Creative Commons enables educational resources to evolve and be improved through peer and student edits. Creative Commons licensed OER are living documents that can be built upon and improved not only by authors and publishers, but by colleagues and students as well. For example, when a University of Michigan professor was dissatisfied with currently available textbooks in his area of computer science, he was able to use an existing openly licensed textbook as the basis for developing a new book that met his needs, by changing the overall focus of the book, adding his own original content, and restructuring the original text.

Creative Commons enables easier discovery of educational resources on the web. Creative Commons licenses provide the legal infrastructure that allows OER to be shared, but there is an important technical component to sharing successfully as well. Creators of OER want to make sure their work is visible to users, and learners and educators need to be able to find resources relevant to their chosen subject. Creative Commons has further broadened the impact of OER by embedding each of its licenses with software code that makes the license terms machine-readable—that is—discoverable by a search engine. In addition to creating licenses that can be indexed by prominent search engines such as Google and Yahoo. Creative Commons is also exploring ways to improve search and discovery of OER by helping to build a common metadata vocabulary for educational resources via the Learning Resource Metadata Initiative (LRMI).

How Creative Commons Makes Sharing, Adapting and Finding OER Easy?

Creative Commons offers creators a simple, standardized way to grant copyright permissions to their work. Creative Commons licenses are built on top of copyright law, allowing creators to change their copyright terms from the default “all-rights-reserved” to “some rights reserved.” Creators may choose among a suite of six Creative Commons licenses that are free-of-charge, easy to use, and help to standardize what is “open” on the Internet. A rights-holder may choose one or more of the following terms:

Attribution- all Creative Commons licenses require that others who use your work must give you credit the way you request, but not in a way that suggests you endorse them or their use. If they want to use your work without giving you credit or for endorsement purposes, they must get your permission first.

NonCommercial- you let others copy, distribute, display, perform, and (unless you have chosen No Derivative Works) modify your work, but not for commercial purposes unless they get your permission first.

ShareAlike- you let others copy, distribute, display, perform, and modify your work, as long as they distribute any modified work on the same terms. If they want to distribute your modified work under other terms, they must get your permission first.

NoDerivatives- you let others copy, distribute, display and perform only original copies of your work. If they want to modify your work, they must get your permission first.

Creative Commons is a global standard- Creative Commons licenses are the most widely used open content licenses in the world, and have been legally and linguistically adapted to more than 70 jurisdictions worldwide. Government bodies, universities, and libraries around the world leverage Creative Commons licenses to increase access to, and the impact of, their educational resources. For example, see European Schoolnet, a group of 31 Ministries of Education in the EU making educational resources available under Creative Commons BY, The OpenCourseWare Consortium, a collaboration of over 200 universities world-wide making high quality courses available under Creative Commons licenses, and eIFL.net, partnering with national library consortia to educate librarians about Creative Commons.

Creative Commons licenses are available in three different formats. The first is a human-readable deed that simplifies the terms of each license into a few universal icons and non-technical language. The second is the lawyer-readable terms of the license itself, which have been vetted by a global team of legal experts. And the final layer is the machine-readable code enables search and discovery.

Factors that Determine the Success of OER

The success of OER depends on legal and technical interoperability. The OER movement is poised to greatly further global access to and participation in education, but only if a critical mass of educational institutions and communities interoperate legally and technically via Creative Commons. This will require institutions, teachers, and policymakers in all arenas to implement and recommend use of CC's tools for educational resources. One of the fundamental design principles of all CC licenses is that of granting permission in advance to the public, without the need for users of the work to seek permission first. This feature is core to the success of OER and sharing. We actively discourage practices that interfere with or undermine that feature, particularly when those policies expressly require that users or some subset of users must ask permission first.

Modifying the Creative Common Licenses

Creative Commons recognizes that we cannot control or prohibit separate agreements or understandings that involve or affect our standard licenses. After all, Creative Commons is not a party to the licenses – they are agreements between licensors and licensees. However, we have long insisted that Creative Commons trademarks and branding not be used in connection with separate agreements, understandings, and interpretations that may cause confusion for the public, or create any ambiguity in or inconsistency with the standard terms and conditions offered by a Creative Commons license.

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C. ICT Trends in Education

Over the years ICT has become more and more indispensable to the functioning of modern societies, these same technologies are equally indispensable to learning institutions. The following are trends shaping up in the education systems across the globe because of ICT (Laudon and Laudon , 2010):

Mobile Learning- new advances in hardware and software are making mobile “smart phones” indispensable tools.

Cloud computing- the implications of this trend for education systems are huge; they will make cheaper information appliances available which do not require the processing power or size of the PC.

One-to-One computing. The trend in classrooms around the world is to provide an information appliance to every learner and create learning environments that assume universal access to the technology.

Ubiquitous learning- school systems around the world are developing the ability to provide learning opportunities to students “anytime, anywhere”.

Gaming- the phenomenal success of games with a focus on active participation, built in incentives and interaction suggests that current educational methods are not falling short and that educational games could more effectively attract the interest and attention of learners.

Personalized learning- education systems are increasingly investigating the use of technology to better understand a student’s knowledge base from prior learning and to tailor teaching to both address learning gaps as well as learning styles.

Redefinition of learning spaces- schools around the world are re-thinking the most appropriate learning environments to foster collaborative, cross-disciplinary, students centered learning.

Teacher-generated open content- empowering teachers and networks of teachers to both identify and create the learning resources that they find most effective in the classroom. Many online texts allow teachers to edit, add to, or otherwise customize material for their own purposes, so that their students receive a tailored copy that exactly suits the style and pace of the course

Smart portfolio assessment- the collection, management, sorting, and retrieving of data related to learning will help teachers to better understand learning gaps and customize content and pedagogical approaches.

Teacher managers/mentors- the role of the teacher in the classroom is being transformed from that of the font of knowledge to an instructional manager helping to guide students through individualized learning pathways.

D. Case Studies/Best Practices of ICT in Education

Moodle

Type of Learning Management System

An LMS designed to support both blended learning and 100% online courses [11].

Application Description

Moodle is a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalised learning environments. It is built by the Moodle project which is led and coordinated by Moodle HQ, an Australian company of 30 developers which is financially supported by a network of over 60 Moodle Partner service companies worldwide.

Application Purpose

With over 10 years of development guided by social constructionist pedagogy, Moodle delivers a powerful set of learner-centric tools and collaborative learning environments that empower both teaching and learning. A simple interface, drag-and-drop features, and well-documented resources along with ongoing usability improvements which makes easy to learn and use it.

Stakeholders

The stakeholders involved in the Moodle project are available in the link below:

<https://moodle.org/dev/contributions.php>.

Main Characteristics of the eLearning tool

- Blended Learning,
- Easy to use,
- Free with no licensing fees,
- Always up-to-date,
- Multilingual,
- Customisable,
- Scalable,
- Robust, secure and private.

Scriyb

Type of Learning Management System

Synchronous cloud-based mobile education engagement platform that allows a single teacher to effectively instruct thousands of students[12].

Application Description

Scriyb uses a patented methodology that segments large numbers of students into smaller groups (30 or less) of students, to create Ideal Cohort Peer-to-Peer Social Learning, and ideal teacher-student matching, and uses a patented communication management tool.

Stakeholders

The software is developed by a company named Scriyb founded in 2014 in the United States.

Some of the Main Characteristics of the eLearning tool

- Blended Learning,
- Built-in Course Authoring,
- Classroom Management,
- Mobile Learning,
- Licensing Fee is required,
- Social Learning.

EduBrite

Type of Learning Management System

A platform which consists of simple to use online editor to create customized courses by importing existing documents, videos or linking external resources[13].

Application Description

The platform allows to create assessment and certification programs which can be taken from anywhere, anytime using a web browser or native iPad applications. The system tracks all learning activities and provides dynamic reporting.

Stakeholders

The software is developed by a company named EduBrite Systems founded in 2009 in the United States.

Some of the Main Characteristics of the eLearning tool

- Blended Learning,
- Built-in Course Authoring,
- Classroom Management,
- Mobile Learning,
- Licensing Fee is required,
- Social Learning.

Path Event Learning

Type of Learning Management System

A cloud-based approach to educational content management and designed specifically for lecture-based learning applications[14]

Application Description

Optimized to deliver media content from educational events, it allows you to manage all of your content, such as conference recordings, recorded lectures from live and virtual meetings, as well as traditional e-learning presentations.

Stakeholders

The software is developed by a company named Blue Sky Product founded in 2002 in the United States.

Some of the Main Characteristics of the eLearning tool

- Blended Learning,
- Built-in Course Authoring,
- Synchronous Learning,
- Mobile Learning,
- Licensing Fee is required,
- Asynchronous Learning.

Reflective Activities

- Explain how Creative Commons licenses help educators to broaden the impact of their own educational resources.
- How Creative Commons makes sharing, adapting and finding of OER easy?
- What are the types of Creative Commons Licenses operational?
- Is Modifying a Creative Common License possible? If yes, how?
- Discuss the different types of MOOCs models by highlighting their distinguishing feature as well as their limitations in the context of developing countries.
- Discuss the key challenges of MOOCs use in developing countries.
- Explain what personalized learning means.

Conclusion

MOOCs is becoming more and more popular both in the developed as well as developing world. However, MOOCs progression and its impact in the developing world are very limited because of a myriad of factors.

Assessment

1. Clarity and completeness of the essay or write up, learners ability to prepare the write up using owns word as opposed to copying and pasting from the reference sources used as they are.

Unit Summary

Over the past several decades the experience of introducing different ICTs in the classroom and other educational settings suggests that the full realization of the potential educational benefits of ICTs is not automatic. The effective integration of ICTs into the educational system is a complex, multifaceted process that involves not just technology- indeed, given enough initial capital, getting the technology is the easiest part—but also curriculum and pedagogy, institutional readiness, teacher competencies, and long-term financing, among others. However, developing and customizing a learning platform or software-based learning management systems has now become a lot easier because of the availability of open source courseware that can be modified and tailored to the specific needs of a learning institutions. In this unit a broader range of issues pertinent to the use of ICT in education have been discussed- issues covered include ICT-Powered Learning Management Systems, Open Educational Resources, Massive Open and Online Courses(MOOCs), Creative Commons and Open Educational Resources, ICT Trends in Education, and best practices of ICT use in education have been covered.

Unit Assessment

Instructions

A solid understanding of the diverse set of issues discussed in this unit is critical, in case of doubts learners are advised to read the notions by going back to the specific sections where the ideas have been presented as well as the reference materials recommended.

1. Explain the reasons as to why the uptake of ICT-powered Learning Management Systems in developing country is low.
2. What are the technical, social or political or cultural challenges and barriers of implementing ICT-powered learning Systems in developing countries?
3. What makes the eLearning platform “Moodle” more suitable as well as sustainable for developing countries?
4. Discuss the key enabling factors for ICT-powered Learning Management Systems.

Grading Scheme

The course facilitator is required to prepare subjective questions with respect to what is covered in this unit is required. The above questions are included as sample to aid in course module facilitators on how to prepare unit assessment questions, and as suggested in the module assessment plant, the unit assessment weight should not exceed 5%.

Answers

The following are items that need to be considered during evaluation. Presentation of contents, organization, clarity, ability to write in one’s own words spelling and grammar errors.

Unit Readings and Other Resources

- Wiki- ICT in Education, https://en.wikibooks.org/wiki/ICT_in_Education/Introduction, Date accessed- August 2015.
- Things You Should Know About LMS Alternatives, <https://net.educause.edu/ir/library/pdf/ELI7062.pdf>.
- An Introduction to Learning Management Systems, <http://seertechsolutions.com/choosing-an-lms/an-introduction-to-learning-management-systems>, August 2015.
- Wiki- Learning Management System, https://en.wikipedia.org/wiki/Learning_management_system, Date Accessed- September 2015.
- Wiki- Open Educational Resources, https://en.wikipedia.org/wiki/Open_educational_resources, Date Accessed- September 2015.
- Things You Should Know About Open Educational Resources, <http://net.educause.edu/ir/library/pdf/eli7061.pdf>.
- Communication and Information, <http://www.unesco.org/new/en/communication-and-information/access-to-knowledge/open-educational-resources/what-are-some-examples-of-oer-projects/>, Date Accessed- September 2015.
- Li Y., Sheila M., Wilbert K., JISC C., Open Educational Resources – Opportunities and Challenges for Higher Education, http://wiki.cetis.ac.uk/images/0/0b/OER_Briefing_Paper.pdf.
- Rory McGreal, Wanjira Kinuthia and Stewart Marshall, Open Educational Resources: Innovation, Research and Practice https://oerknowledgecloud.org/sites/oerknowledgecloud.org/files/pub_PS_OER-IRP_web.pdf.
- https://wiki.creativecommons.org/wiki/Creative_Commons_and_Open_Educational_Resources, Date Accessed- September 2015.
- https://docs.moodle.org/29/en/About_Moodle, Date Accessed- September 2015.
- Scriyb, <http://www.capterra.com/learning-management-system-software/spotlight/144498/Scriyb/Scriyb>, Date Accessed- September 2015.
- <http://www.capterra.com/learning-management-system-software/spotlight/124777/EduBrite/EduBrite%20Systems>, Date Accessed-September 2015.
- Path Event Learning Platform, <http://www.capterra.com/learning-management-system-software/spotlight/143905/Path%20Event%20Learning%20Platform/Blue%20Sky%20Broadcast>, Date Accessed- September 2015.

Module Summary

Information and Communication Technology (ICTs) have emerged as strong tools for development processes worldwide and it is now considered as the most critical and indispensable tool to address developmental challenges of our time. Its application has transcended almost all sectors including healthcare, education, agriculture and governance. The use of ICTs in these sectors has taken root in the global north. Despite these developments, in most part of the global south, there is yet to be an effective environment to maximize the benefits from ICT. In this module, learners have been introduced to the potential of ICT in streamlining the activities of the five sectors. As well as adapting best practices of ICT use in the sectors, the module has laid down the foundations for learners to be able build the skill as well as knowledge to think innovatively towards addressing developmental challenges of our time.

Final Exam Rubric

NO	Unit Description	Number of questions	Weight (30 %)
1	Unit 1 ICT4D Basics	2 essay questions each weighing 2 mark.	4%
2	Unit 2: ICT and Governance	2 essay questions each weighing 3 mark.	6%
3	Unit 3: ICT and Agriculture	2 essay questions each weighing 4 mark.	8%
4	Unit 4: ICT and Healthcare	2 essay questions each weighing 3 mark.	6%
5	Unit 5: ICT and Education	2 essay questions each weighing 3 mark.	6%

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