

Full Length Research Paper

Pedagogic possibilities of ICTs and technology affordances in an increasingly networked environment in support of sustainable development

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The research project seeks new opportunities/ directions of learning and teaching in an increasingly networked world, and how they can benefit people in developing countries in support of sustainable development. The research agenda is aimed at studying how interconnected information and communication technologies (ICTs) can expand the reach of educational opportunities and improve learning outcomes as technology affordances. The main research question is - What are the pedagogic possibilities of ICTs and technology affordances in an increasingly networked environment that can impact/ benefit participative collaborative inclusive communities of learning in support of sustainable development?

Key words: ICT, technology affordances, sustainable development, pedagogic possibilities.

INTRODUCTION

The research project covered 23 selected African countries where the higher education institutions are members of the African Council for Distance Education (ACDE). The three main phases of the project are as follows:

1. Phase 1: ACDE Survey on OERs and MOOCs among the 70 ACDE member institutions
2. Phase 2: Assessment of the enabling ICT learning environment with respect to ICT infrastructure and connectivity
3. Phase 3: Pedagogic possibilities of ICTs and technology affordances for teaching and learning experiences from various African institutions of higher learning and these support sustainable development.

A networked environment in this context is inclusive of connected nodal networks, blended learning, distance learning, asynchronous / synchronous learning, computer supported collaborative learning, community of learning, teachers and students, interactive learning (between learners, between learners and teachers, between

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learners and content), co-creative, collaborative, inclusive spaces, participatory learning context and spaces, time on task, feedback mechanism (learner, group, country), learner analytics, and integrated tutoring systems. *Pedagogy* is the discipline that deals with the theory and practice of education; it thus concerns the study and practice of how best to teach.

An *affordance* is often taken as a relation between an object, or an environment, and an organism that affords the opportunity for that organism to perform an action (Kabanda, 2014). Affordances are the interactions between users and tool, i.e., the perceived and actual properties of an object that determine how it could possibly be used. The tool prompts, guides, or constrains the users depending on their previous experiences (Salomon, 1990). The technology considerations in this research include learning analytics, MOOCs, OERs, free and open source, technology alternatives, asynchronous/synchronous, interactive technology, scaleable and usable in a developing world. Areas of Technology Affordances exist in the following forms:

1. Perception/action, Metaphor/learning, Techniques for Input/ Output
2. New forms of expertise
3. Foundations of learning and cognitive activity
4. Models of innovative knowledge communities
5. Progressive inquiry learning

“*Sustainable development*” is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development has remained elusive for many African countries. Africa's efforts to achieve sustainable development have been hindered by conflicts, insufficient investment, limited market access opportunities and supply side constraints, unsustainable debt burdens, historically declining levels of official development assistance and the impact of HIV/AIDS (Kabanda, 2012). Sustainable Development begins with education in general and human capital development in particular. Education is the centrality of the following sustainable development elements (UNESCO, 2014, <http://unesdoc.unesco.org/images/0023/002305/230508e.pdf>).

1. Poverty reduction
2. Nutrition improvement
3. Health gains
4. Life-long learning
5. Gender equality and empowerment
6. Water and energy sustainability
7. Economic growth
8. Inequality reduction
9. Urban development
10. Environmental protection/resilience
11. Peaceful, just and inclusive societies

The common challenges of university education include the following:

1. Learning and advancement of understanding in social interaction, which often includes the social nature of knowledge and the zone of proximal development.
2. Practices of collaborative knowledge building are affected by understanding learning as acquisition and knowledge creation process, advancement of communal knowledge, and having schools as knowledge building communities.
3. Expert-like problem solving requires solving authentic problems, contacts to expert culture, and distributed expertise and sharing of ideas.
4. Using modern technology as a tool for collaboration.

Statement of the problem

African countries need to adequately prepare for a strategic response to new technologies associated with open educational resources (OERs), massive open online courses (MOOCs), e-learning and mobile learning. There is a need to explore and develop new opportunities/directions of learning and teaching in an increasingly networked world, and how they can benefit people in developing countries, i.e. new pedagogic possibilities and technology affordances in an increasingly networked environment.

Purpose or aim

The purpose of the research was to investigate on the pedagogic possibilities of ICTs and technology affordances in an increasingly networked environment that can impact/ benefit participative collaborative inclusive communities of learning in support of sustainable development.

Main research question

What are the pedagogic possibilities of ICTs and technology affordances in an increasingly networked environment that can impact/ benefit participative collaborative inclusive communities of learning?

Objectives

The objectives of the research are to:

1. Ascertain whether or not open and distance learning (ODL) pedagogy and technology can support sustainable development
2. Assess the usage pattern of OERs, MOOCs, e-learning, mobile technology connectivity and applications in Africa,

and

3. investigate on the pedagogic possibilities of ICTs and technology affordances can be used to improve the teaching and learning inclusive of applications of OERs, MOOCs, e-learning and mobile technology in African countries,

Research questions

1. Can ODL pedagogy and technology support sustainable development?
2. What is the level of awareness on OERs, MOOCs, e-learning and mobile technology among the African higher education institutions?
3. What are the pedagogic possibilities in ICTs and technology affordances that can add value to the teaching and learning systems and process?

Research hypothesis

Pedagogic possibilities in ICTs and technology affordances are related to the diffusion and adoption of mobile technology and e-learning in support of sustainable development in Africa”.

Important definitions for open Educational Resources (OER), Massive open online course (MOOCs) and strategy for MOOCs/OER are shown In Appendix 1.

The purpose of the African strategy for OERs and MOOCs is to provide a recommended approach on what is to be done and how these new technologies can be used in open and distance learning (ODL) with respect to the following challenging areas:

1. Knowledge and information presented over multiple learning platforms;
2. Online learning often lacks an effective learner support mechanism and any responsiveness to the individual learner's cultural and professional experience, particularly those from underrepresented groups;
3. Online learning environments struggle to identify students disengaging from courses or failing to cope with material being taught.
4. Learners need to be more responsible for their own learning, able to manage their own time, and maintain their own motivation to complete courses;
5. Learners need reliable and inexpensive access to the Internet for extended periods of time in an environment conducive to learning;
6. Reflection and critical analysis are challenging to support without individual teacher attention on the work of the student.

LITERATURE REVIEW

The basic driving force behind economic growth is

technological change. Technological change is endogenous, being determined by deliberate activities of economic agents acting largely in response to financial incentives. The defining characteristic of ideas/knowledge is that once the cost of creating a new set of instructions has been incurred, the instructions can be used over and over again at no additional cost (Romer, 1990). High – skilled labour is complementary with capital and low-skilled labour, but high-skilled workers enhance technological innovations and their diffusion. The main implication is that a continuous outflow of high – skilled labour creates the Brain Drain problem. Trade and endogenous growth have been linked to growth through technological and knowledge spillovers and learning. The endogenous economic model, which links output per worker to the capital per worker and level of investment in technological change’ is illustrated in Figure 1, adapted by Kabanda (2012).

The Technology Acceptance Model (TAM) is an information systems theory that models how users come to accept and use a technology. TAM proposes that perceived ease of use and perceived usefulness predict applications usage. The Technology Acceptance Model (TAM) in which system use is a response that can be explained or predicted by user motivation is directly influenced by external stimulus consisting of the actual system’s features and capabilities (Davis, 1985), as shown in Figure 2.

TAM is an adaptation of the Theory of Reasoned Action (TRA), a widely studied model from social psychology which is concerned with the determinants of consciously intended behavior (more general theory) (Chuttur, 2009). This is illustrated in Figure 3. According to TRA, a person’s performance of a specific behavior is determined by his/her behavioral intention (BI) to perform the behavior and BI is jointly determined by the person’s attitude (A) and subjective norm (SN) concerning the behavior in question. The revised TAM model is the TAM 2 model shown in Figure 4.

Figure 5 shows the link between technology, organization and the environment.

The taxonomy of ICT affordances (Wijekumar et al., 2006) highlight the following key elements in order to maximize innovation opportunities:

- a. Accessibility - this is where the Internet ‘affords’ opportunities for accessing information and knowledge in a new way. This affordance faces a primary challenge from finding to selecting relevant information.
- b. Speed of change - this refers to attempts to understand the question of how technology can be used to enable students to navigate their way through the myriad of changing information and make more informed decisions’.
- c. Other affordances relevant to the learner include diversity, communication and collaboration, reflection, multi-modal and non-linear learning, etc. It is argued that ‘Perhaps new forms of reflection and critique will emerge

SOLOW NEOCLASSICAL GROWTH MODEL

(SOURCE: JONES, 1988 CHAPTER 2)

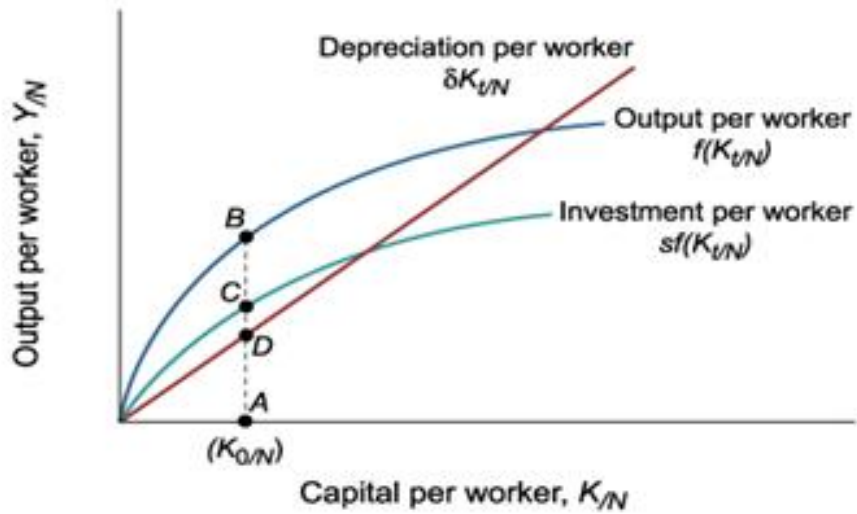


Figure 1. Endogenous growth model. Source: (Kabanda, 2012).

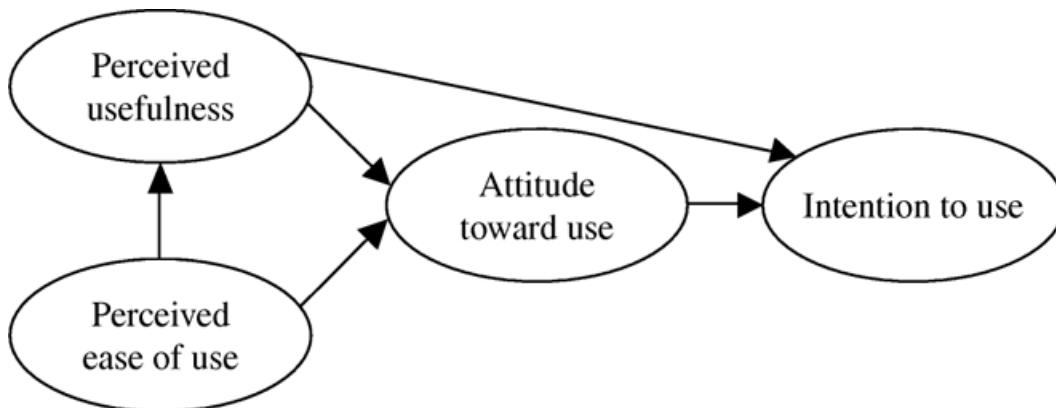


Figure 2. Davis' Technology Acceptance Model (Davis, 1989:985).

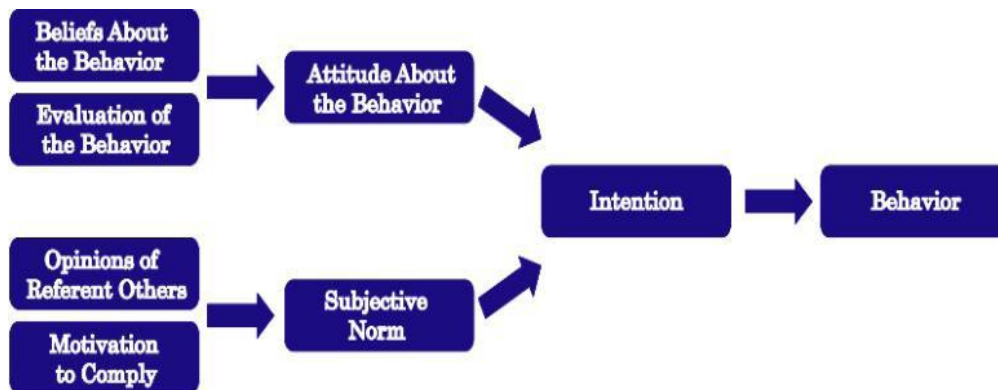


Figure 3. Theory of Reasoned Action (Hale et al., 2002:163).

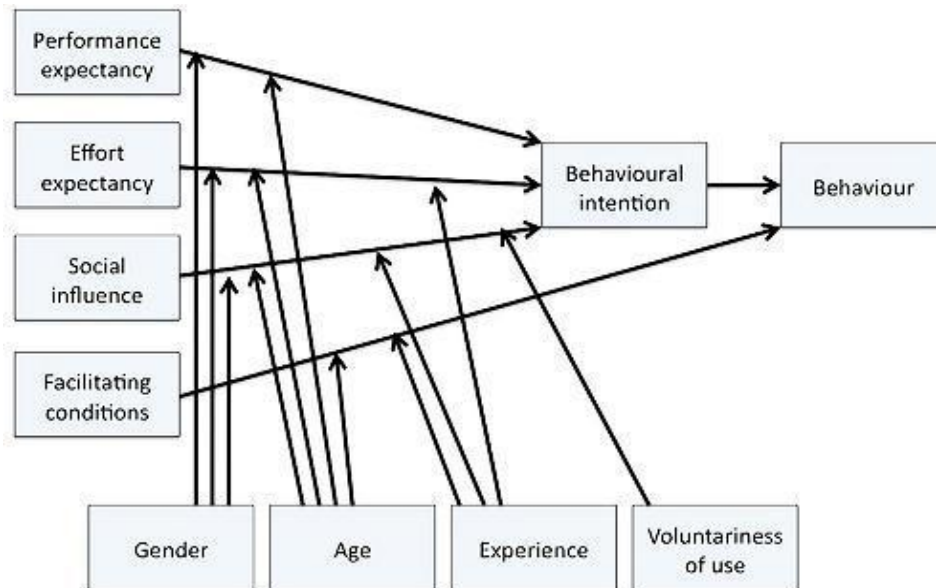


Figure 4. Technology Acceptance Model 2 (Venkatesh and Davis, 2000:188).

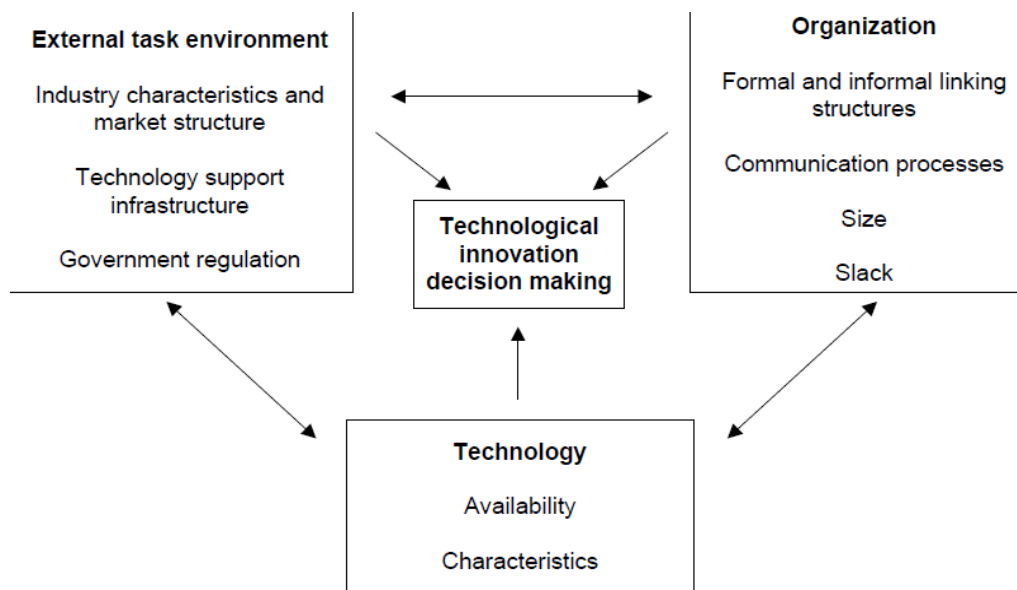


Figure 5. Technology, organization and environment framework (Tornatzky and Fleischer, 1990, adapted from Oliveira et al., 2010:112).

in response to more transitory and digital text' in Wijekumar et al., 2006).

The concept of technology affordances is instrumental in identifying innovation in e-learning and mobile learning, and these show innovative results in the following areas (Traxler, 2009):

1. Technology-driven mobile learning where specific

technological innovation is deployed in an academic setting to demonstrate technical feasibility and pedagogic possibility;

2. Miniature but portable e-learning that uses mobile, wireless, and handheld technologies that re-enact approaches and solutions already used in conventional e-learning;

3. Connected classroom learning that supports collaborative learning and may include interactive whiteboards;

4. Informal, personalized, situated mobile learning enhanced with additional functionality to deliver educational experiences;
5. Mobile training/ performance support to improve the productivity and efficiency of mobile workers; and
6. Remote/rural/development mobile learning that addresses environmental and infrastructural challenges of delivering and supporting education over a wider geographic dispersion.

The recommended model for e-learning and mobile learning is the Frame Model (Koole, 2009), which is illustrated in Figure 6. The advantages of mobile learning (Koole, 2009) are:

1. Wireless, networked mobile devices can enable learners to access relevant information when and where it is needed at various locations.
2. The ability to access a variety of materials from anywhere at anytime can provide multiple cues for comprehension and retention.
3. Learning within specific contexts can provide authentic cultural and environmental cues for understanding the uses of information which may enhance encoding and recall.
4. Well-implemented mobile education can assist in the reduction of cognitive load for learners. While it is difficult to determine how to chunk information, differing patterns of presentation and amounts of information can potentially help learners to retain, retrieve, and transfer information when needed.

RESEARCH METHODOLOGY

The cycle of research indicates the induction (qualitative) and deduction (quantitative) routes. The main research methodology used is largely quantitative with the research design being a survey, but supported by qualitative approaches where Focus Group discussions were held. A survey was conducted among the ACDE member institutions to assess the level of awareness of OERs, MOOCs, e-learning and mobile technology. Diffusion of mobile technology was assessed mainly through the trends in usage patterns with respect to the major ICT indicators such as teledensity, mobile density and internet penetration levels. Data on infodensity were obtained from the International Telecommunications Union (ITU) (<http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>).

Data on Infodensity covered 23 African countries for the period 2000 to 2013. The 23 countries covered by the qualitative study are Angola, Botswana, Burundi, D.R. Congo, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Nigeria, Rwanda, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe.

A qualitative approach was taken where Focus Group discussions were held among:

- a) A total of 30 workshop participants of the ACDE-TCC member institutions held in Harare, Zimbabwe, on 11th November, 2014 to share experiences on OERs and MOOCs.
- b) A total of 25 participants from among the 93 delegates to the DEASA held in Mauritius on 5th and 6th December, 2014.

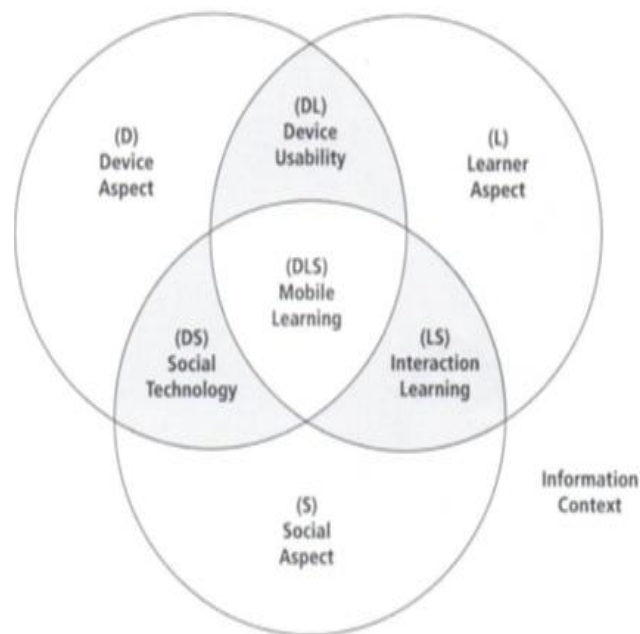


Figure 6. The Frame Model (Koole, 2009).

RESULTS AND ANALYSIS

Phase 1: ACDE Survey on OERs and MOOCs

Survey results on the status of MOOCs/OERs amongst ACDE institutions conducted in January 2014 have indicated that there is a diversity and confusion in terms of the way ODL practitioners conceive concepts such as Distance Education, Open Learning, OER, MOOCs, E-learning and Open Content.

The Key Enablers to the ACDE Strategy are:

1. Raising awareness regarding OERs.
2. Creation of collaborative communities and networks.
3. Availability and affordability of ICT infrastructure and connectivity.
4. Capacity Development.
5. Sustainability of OER
6. Quality Assurance

The critical success factors for the successful implementation of the strategy are:

1. Sharing good and bad learning experiences
2. Sufficient piloting
3. Curriculum review

It was observed that the following factors facilitate the strategic importance of e-learning in Africa:

1. Internet access;

Fixed-telephone subscriptions % 2000-2013

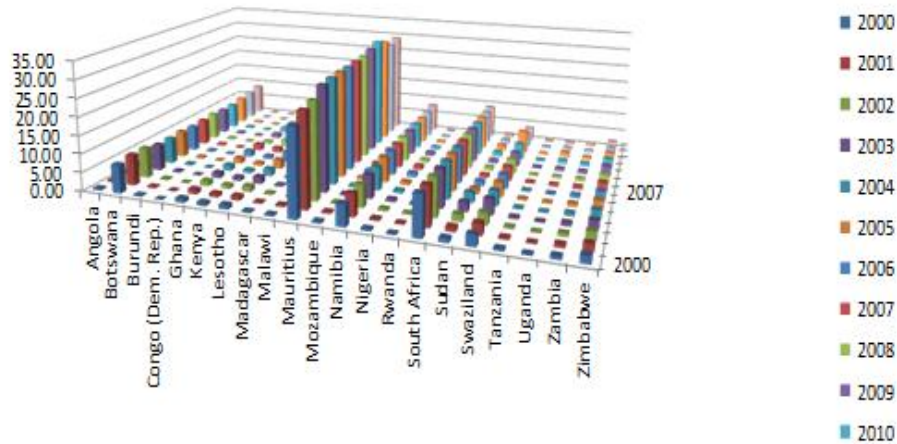


Figure 7. Fixed broadband subscriptions 2000-2013.

Mobile-cellular telephone subscriptions % 2000-2013

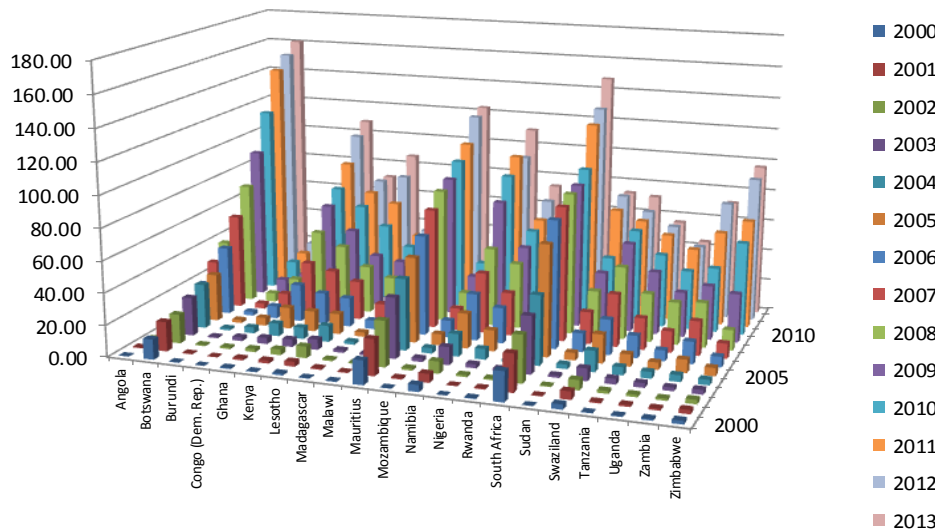


Figure 8. Fixed telephone subscriptions.

2. Advances in digital technologies;
3. Increasing bandwidth and better delivery platforms making e-learning feasible and attractive;
4. Availability of high-quality e-learning products and services; and
5. The emergence of compatible and usable technology standards.
6. Research and technological development
7. Best practices

Phase 2: Assessment of the enabling ICT learning environment with respect to ICT infrastructure and connectivity.

The analysis of the infodensity of various ICT development indices are shown below. Figure 7 shows the fixed (wired)-broadband subscriptions for the period 2000 to 2013 as a percentage of the population of each the African countries. Figure 8 shows the fixed telephone subscriptions for the same countries.

There has been very little investment in African countries on fixed telephony and fixed broadband for the period between 2000 and 2013, and this region has the lowest levels in the world. Mauritius has the highest fixed-telephone subscription of 25% and fixed-broadband subscription that has increased to 15%, whilst the rest of the African continent remained at less than 5 and 2%,

Fixed (wired)-broadband subscriptions 2000-2013

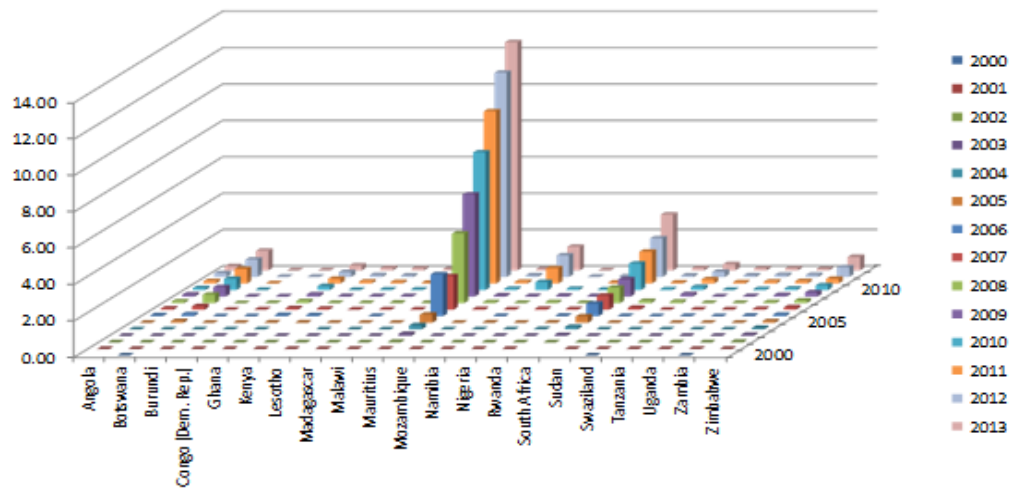


Figure 9. Mobile cellular subscriptions:2000-2013.

Individuals using the Internet % 2000-2013

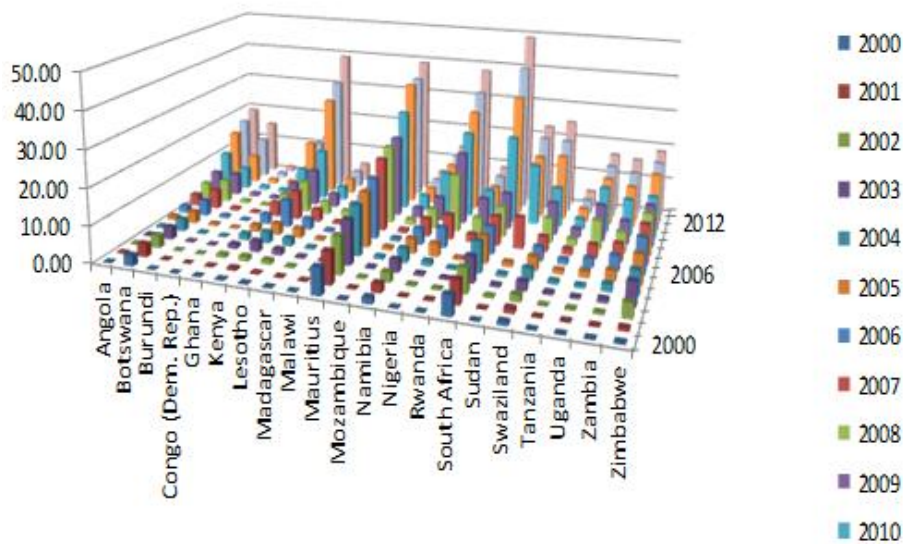


Figure 10. Internet penetration rate: 2000-2013.

respectively. However, the same African countries showed phenomenal growth in mobile density (Figure 9) and internet penetration levels (Figure 10) and these show the fastest growth rates in the world. Botswana, Mauritius, South Africa and Zimbabwe now have mobile density levels that have reached or exceeded 100%.

Phase 3: Technology affordances and pedagogic possibilities of ICTs for teaching and learning experiences from various African institutions of higher learning.

Focus Group discussions were held with a group of 25 participants with respect to ODL pedagogy and technology affordances chaired or facilitated by the researcher. The discussions centred on the following areas, whose summaries are shown below:

1. ODL pedagogy and technology affordances
2. Development
3. Use of Facebook
4. Use of blogs

5. Mobile learning
6. Technology integration in teaching and learning
7. Technology mediated learning
8. Multimedia technology and students learning style

ODL pedagogy and technology affordances

Can ODL pedagogy and technology support sustainable development?

1. It was agreed that there is a strong relationship between open and distance learning (ODL) and sustainable development.
2. However, this requires a new transformational pedagogy with successful student outcomes and that accommodates different learning styles.

Higher Education and Sustainable Development

1. Higher education is a determinant of economic growth, improved technology, teacher training, etc.
2. Education is a catalyst for Sustainable Development with respect to Poverty reduction; Nutrition improvement; Health gains; Life-long learning; Gender equality and empowerment; Water and energy sustainability; Economic growth; Inequality reduction; Urban development; Environmental protection/resilience; Peace and justice.

Use of Facebook

1. Most of the students have access to and extensively use social media such as Facebook, twitter, etc.
2. It was observed that many students visit Facebook in general more than 21 times per week. However, Facebook Groups are currently used only for announcements and collaborative engagements. Facebook can be used beyond collaboration further in teaching and learning.

Use of blogs

1. Use of a blog is another innovation that is now being explored on an experimental basis. Most of the learner management systems are now clothed with salient features that include the use of a blog in education.
2. It is important to explore the use of blogs for reflective purposes when teaching courses.
3. However, the results are currently showing low posting on blogs as the blog is not yet an integral part of the assessment process.
4. Nevertheless, the student experiences show positive comments on the teaching

Mobile learning

1. Mobile learning (m-learning) experiments are being

conducted in different forms and styles, as almost all the students in higher education institutions have access to smart phones.

2. Academic attention is on the increase on m-learning, through descriptive and exploratory researches conducted so far.
3. However, the future of m-learning requires exploration on other mobile devices and comparison with other universities, paying particular attention should be given on gender and technology gaps.

Technology integration in teaching and learning

1. Most students have smart phones, iPads, tablets and laptops. However, there is very little integration into education or curricula. Lecturers were not confident and not well prepared for the integration
2. Generally, the infrastructure is relatively poor and not fully exploited in the institutions, lack of access to affordable high speed internet connectivity and lack of integration.

Technology mediated learning

1. Technology enabled pedagogy offers responsive and on-demand education, technologies of instruction guided by availability to target population, affordability and access with socio-cultural relevance, e.g. the use of the radio in teaching and learning.
2. It is important to engage in research that solves real contextually relevant problems, lead government and shareholders in finding better ways of developing the country, use technology to enable wide distribution of relevant solutions to real life problems, and producing a social participant graduate.

Multimedia technology and students learning styles

1. According to the Brain Laterization Theory, individuals have different brain dominances, and so learn differently.
2. Multiple Intelligence Theory and Cognitive Theory of Multimedia Learning bring a new dimension that requires teachers to carefully study the learning styles of students.
3. There are relationships and correlations between students' learning styles and the effective use of multimedia. The concept of Critical Thinking is used as a set of skills and dispositions.

Conclusion

Sustainable development begins with education. There is a strong relationship between open and distance learning (ODL) and sustainable development. Most of the students have access to and extensively use social media such as

Facebook, twitter, etc. Use of a blog is another innovation that is now being explored on an experimental basis for reflective purposes. Mobile learning experiments are being conducted in different forms and styles, as most students have access to smart phones. There is lack of access to affordable high speed internet connectivity and lack of ICT integration into teaching and learning. Technology mediated teaching and learning can produce a graduate who is a change agent. Assessing the IQ of students and its relation to the effectiveness of different types of multimedia enriched instruction is critical. Challenging assignments stimulate critical thinking.

The utility of TAM for explaining acceptance of mobile technology and e-learning by learners was evaluated. Results showed that perceived usefulness is more important in determining intention to use the technology than attitude toward using. The technology acceptance model (TAM) proposes that perceived ease of use and perceived usefulness predict applications usage (Kabanda, 2014). Affordance offers a distinctive perspective on the use of ICT in education because of its focus on possibilities for action. The FRAME model for mobile learning is adopted as a framework for implementation to manage the process resulting from the convergence of mobile technologies, human learning capacities and social interaction. However, the cost for bandwidth per month is a major obstacle to the fast diffusion of mobile technology and e-learning in Zimbabwe.

In conclusion, it is indeed true that “Pedagogic possibilities in ICTs and technology affordances are related to the diffusion of mobile technology and e-learning in Africa”.

Conflict of Interests

The author has not declared any conflict of interests.

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APPENDIX 1: IMPORTANT DEFINITIONS

Important definitions include the following:

1. Open Educational Resources (OER) -. a part of the global open content movement, are shared teaching, learning, and research resources available under legally recognized open licenses, usually free for people to reuse, revise, remix, and redistribute. High-quality OER can save teachers significant time and effort on resource development and advance student learning inside and outside the classroom. It is envisaged that open sharing of resources has the potential to fuel collaboration, encourage the improvement of available materials, and aid in the dissemination of best practices.
2. Massive open online courses (MOOCs) - have stimulated an international burst of activity examining the role technology plays in higher education. MOOCs offer the opportunity to explore models of pedagogy with fresh eyes, and have features that are both attractive and threatening (Marshall, 2013).
3. The strategy for OERs and MOOCs is a statement of intent underpinned by a set of guiding principles and strategic priorities in order to adequately prepare for a strategic response to these new technologies. It places emphasis on the support that must be provided to students using the open resources, which is very critical in distance education.