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Determining e-Skills Interventions to Improve the Effectiveness of Service Delivery by Community Development Workers

Oludayo O. Olugbara, Richard Millham, Delene Heukelman, Surendra Thakur, Harold Wesso, and Mymoena Sharif
KwaZulu-Natal e-Skills Co-lab, Durban University of Technology, Durban, South Africa

oludayoo@dut.ac.za, richardm1@dut.ac.za, deleneh@dut.ac.za, Thakur@dut.ac.za, hwesso@gmail.com, Mymoena@doc.gov.za

Abstract

This research case study intends to provide a basis for using Information Communication Technology (ICT) to improve the effectiveness of community service delivery to communities. The ineffectiveness in public service delivery to communities is often ascribed to a number of factors, including e-skills deficiencies. In particular, Community Development Workers (CDWs) in South Africa wish to use ICT to improve the effectiveness of public service delivery to their communities, but CDWs often lack adequate e-skills to do so effectively. This lack of e-skills coupled with the subsequent ineffectiveness in service delivery has necessitated the search for innovative service interventions. In this case study, we have considered the measurement of e-skills levels as an important clue because the state of CDWs is an essential prerequisite for creating effective ICT intervention strategies. A set of self-report measures and a pilot e-skills development training that utilized a studio pedagogy in a Blackboard virtual environment were used to measure, validate and improve the e-skills levels of CDWs. The partial credit probabilistic item response theory was used to estimate item difficulty, item discrimination and pseudo-guessing parameters from the pretest self-reports of 327 CDWs and the posttest self-reports of 189 CDWs. These parameters were used in a maximum likelihood scheme to obtain the estimates of e-skills levels of CDWs. A set of interventions, based on the study findings was recommended.

Keywords: Blackboard, Community, Skill, Studio, Training, Worker.

Introduction

The research case study at hand is reported based on the supposition that Information Communication Technology (ICT) can generally be used to improve the effectiveness of public service delivery to communities. However, efforts by Community Development Workers (CDWs) to effectively use ICT to improve their delivery of public services to communities could be jeopardized by

This paper accepted by executive review

their lack of adequate ICT skills/e-skills. The CDWs in South Africa are community based resource persons who play important roles in facilitating community development agendas by collaborating with diverse stakeholders. They are cadres of a special type of participatory change agents who work within the specific communities where they are selected - where they live and to whom they are accountable for their civic roles.

The CDWs are supported by a range of government departments, particularly the local governments to provide assistance to their communities (Raga et al. 2012). They have a limited educational background and a shorter educational training period when compared to the tertiary-educated professional development workers. In particular, e-skills development training has not been an integral part of the agenda for CDWs. The primary selection criteria for CDWs to qualify for a formal employment in the public service is to have attained a minimum of grade 11 or equivalent. The basic training of CDWs is accomplished by doing a learnership program for a period of one year. There will be some theoretical work during the training period, however, the emphasis is generally based on community learning and practical experience.

The understanding of the roles of CDWs, their e-skills levels, the technologies they are able to use and their e-skills needs are pertinent issues that could help to improve their service delivery effectiveness. A case study was nominated as a suitable methodology to explore pertinent information that will increase our understanding of CDWs and enable us to empirically measure their e-skills levels. In South Africa context, e-skills means the ability to use ICT within an emerging information society and the global knowledge economy in which ICT has become an essential requisite for advancement in government, business, education and society at large. The guiding questions examined in this research case study are the following.

a) What tasks are mostly performed by community development workers in the workplace using ICT?
b) How can the e-skills levels of community development workers be practically improved?
c) What ICT intervention is required for community development workers to practically improve their service delivery effectiveness?

In the next section, we advance the discussion on this research case study by providing important background information. Thereafter, we present the procedures that reinforce this research case study. This is followed by the presentation and discussion of the results of this research case study. In the concluding section, we succinctly delineate the key findings of this research case study and decision to recommend a set of interventions for improving the effectiveness of service delivery using ICT.

Background

The background of this research case study summarizes the rationale for the establishment of a community development program and the important civic roles played by CDWs in facilitating community development agendas. In addition, the background information includes the roles of ICT for community development, the impact of e-skills on the effectiveness of service delivery to communities and the rationales for the establishment of the national e-skills plans of action.

Program for Community Development Workers

The United Nations (UN) have emphasized that community development workers' program (CDWP) is a concerned for the global environment with quality of life improvement. In South Africa, the CDWP is an intervention that seeks to improve the quality of the outcomes of public expenditures intended to raise the standards of living of people. The CDWP emphasizes on massive participation of people towards fostering self-reliance and bottom-up strategies for solving

community problems. The South Africa approach to CDWP is based on the principle that by raising awareness among people, the individuals within a community will become highly motivated to appropriately solve their own domain specific problems. The Co-operative Governance and Traditional Affairs (COGTA) have reported that the motivated individuals can develop the required skills to build a collective community that rapidly responds to their own issues.

The fundamental principle of CDWP as articulated in the preamble of the South African constitution, is to "improve the quality of life of all citizens and to free the potentials of each person". The foundation of CDWP reflects the Batho Pele principles of transforming service delivery in South Africa. It should be considered as a service delivery plan to identify service priority areas and to facilitate effective access to the required services. In addition, it was suggested that CDWP should be embedded in the Integrated Development Plan (IDP) at the municipal level (Raga et al. 2012). The CDWP is widely supported as a developmental intervention for the disadvantaged communities in South Africa because it is aimed at developing and promoting generic development activities within communities. The objectives of CDWP include the following:

a) To promote societal goals such as social justice and equity.
b) To serve as a contract for improved service delivery to the people.
c) To serve as a useful tool for the empowerment of citizen education and deepening democracy.

Functions of Community Development Workers

The extension of public services to reach the ordinary citizens is an important contribution for the government to claim as a significant achievement. In South Africa, the majority of communities, especially those in the rural areas, are facing the challenge of not having ubiquitous and equitable accessibility to public services. The Community Development Workers (CDWs) therefore, are functioning as mediators between government and communities in order to increase equitable accessibility of public services in all communities. The many of the functions performed by CDWs can be supported using ICT to improve effectiveness. These functions, according to the 2006 handbook for CDWs, include the following (COGTA 2006):

a) Developing strategies to encourage massive participation of people and raising the awareness of government services and programs within the communities.
b) Alerting people and appropriate service providers on the critical challenges that are associated with the delays in providing basic services to the communities.
c) Disseminating government information to communities in a timely, equitable and in an understandable way.
d) Receiving feedbacks from communities and appropriately directing them to the appropriate service providers.
e) Assisting communities in the effective implementation of government programs, activities and projects.
f) Monitoring and evaluating the impacts of community development projects and submitting reports to the relevant structures of the government.

Information Communication Technology for Development

The notion of Information Communication Technology for Development (ICT4D) was flagged as a global development priority by the United Nations (UN) and the group of Eight (G8) of the industrialized world. The general belief is that technology underpins the highly unparalleled levels of prosperity experienced in the developed world. The understanding of ICT4D as an important development issue is therefore rapidly evolving. ICT is generally seen as a significant

productive force in the socioeconomic development of communities – be it rural or urban. The rapid advancement in ICT has led to the following benefits amongst others:

a) The rising standards of living, increased level of literacy, improved health and life expectancy.
b) The improved security, increased access to data, information and services as well as efficient management of data and information.
c) The facilitation of mobility or flow of people and provision of massive opportunity to establish connectivity as well as enable accelerated development
d) The opportunity for socioeconomic development with the Internet, broadband and the cloud computing technologies playing important roles.
e) The enabler of communities to fully participate in the global knowledge economy and to play key transformational roles in the information society and knowledge economy.
f) The platform for effective delivery of innovative services that are essential for successful global integration.

However, in order to adequately function as an effective ICT user, the knowledge to use, the quality of usage and the intensity of the actual usage are important indicators to access the impact of ICT. The Digital Access Index (DAI) developed by the International Telecommunication Union (ITU) was aimed at measuring the overall ability of individuals in a country to use ICT. In addition, the ICT Development Index (IDI) is a framework to measure the impact of ICT in terms of readiness, usage intensity and ability to use ICT. These indexes (DAI and IDI) stretch the significance of e-skills as an important resource for effective ICT usage. The literature on ICT4D shows that skills, which inevitably include e-skills are prominent factors to deal with social challenges such as poverty, unemployment and inequity facing humanity.

Impact of e-Skills on Service Delivery Effectiveness

The policymakers across the developed parts of the world have persistently insisted that skills are prime to the socioeconomic success of a nation. In particular, ICT skills or e-skills to effectively interact with computing systems are an essential requirement to successfully participate in the knowledge economy and information society. However, there is a growing conviction that if skills are to optimally deliver the kind of services that will lead to huge impact on people, these skills have to be utilized in the workplace and in the business world. However, the existing gap between service delivery efforts of the government and abilities of communities to benefit from the delivered services has been highlighted as a challenge in South Africa (The World Bank, 2011). The delivery of government services at national, provincial and local levels is not always appropriate nor effective in reaching the intended recipients (Pretorius & Schurink 2007). This challenge is often attributed to a number of factors, including the shortage of ICT related skills/e-skills in the local government sphere and the ability to effectively manage human resources. The e-skills challenge, which is generally concerned with the inability of people to meaningfully apply ICT, has been identified as a serious problem in South Africa and even globally.

The building of South Africa e-skills to respond to the service needs, strategic development plans and policies of the country is crucial. However, the lack of ability to adequately use ICT has a deteriorating impact on the effectiveness of service delivery. In the present rapidly changing world of ICT, there is a high likelihood that in the near future, people who do not possess adequate e-skills are likely to have difficulty in accessing quality education and improved services. They will have difficulty in getting decent jobs and they will not be able to improve their social life. In addition, the inability to use ICT has a debilitating impact on the global image of a country. For instance, the lack of appropriate skills was identified as a major contributing factor in ranking South Africa much lower in 2012 than in 2007 in the global electronic readiness (e-

readiness) report produced by the World Economic Forum (WEF). This inability to effectively use ICT has made it difficult for CDWs to adequately provide a bridge between government and communities. In particular, it will be hard for CDWs to completely succeed in fulfilling their crucial obligations without adequate e-skills. The development of e-skills levels of CDWs should be considered an important success factor towards empowering CDWs for effective use of ICT to innovate the delivery process of public services to communities.

National e-Skills Plan of Action as Developmental Lens

The e-Skills Institute (e-SI) is the organ in the Department of Communication (DoC) that initiated the National e-skills Plan of Action (NesPA) as a holistic process to help move South Africa towards a knowledge economy and information society. The underpinning philosophy of NesPA revolves around people-centric development as highlighted in the South Africa (SA) National Development Plan (NDP) (SA-NDP) 2030 of building the needed abilities for increasing self-reliance. The primary goal of NesPA is to develop astute citizens to build an inclusive economy in a developmental stage that is increasingly dominated by modern ICT abilities. The concept of electronic astuteness (e-astuteness) as invented by e-SI, refers to the ability of an individual to use ICT for personal development and self-reliance. The e-astuteness encompasses the ability across the full spectrum of society that would allow individuals and collectives to exploit ICT for individual or group benefit (Mitrovic, et al. 2013).

The DoC is the government department responsible for driving the national agenda of e-Skilling the South Africans for economic prosperity and global competitiveness through the e-SI. The institute was recently launched by the DoC as Ikamva National e-Skills Institute (iNeSI) on 21 of February, 2014 at Durban University of Technology. This memorable launching event was well attended by many professionals and high power government dignitaries, including the Mayor of Ethekwini Municipality, the Minister of Communication and the Minister in the Presidency in charge of the national planning commission. The iNeSI is a merger of the e-Skills Institute (e-SI), the National Electronic Media Institute of South Africa (NEMISA) and the Institute for Satellite and Software Applications (ISSA) into a state-owned company. The iNeSI is a globally recognized collaborative model that allows stakeholders to achieve and to sustain the main objectives of e-Skilling the South Africans. The e-Skilling objectives are aligned to the broadband policy of South Africa Connect (SAConnect), the National Development Plan (NDP) as well as other national and international developmental goals.

The mandate of e-Skilling a large mass of South Africans follows the 2007 recommendations of the Presidential International Advisory Council (PIAC) on the national structural thesis of information society and development. The e-SI has adopted a multi-stakeholders collaborative approach by engaging government, business, civil society, education sector and organized labor to rapidly respond to the e-skills challenge in South Africa. This collaborative approach adopted by e-SI is in line with the deliberations in developing the SA-NDP vision 2030. In these deliberations, a coordination within government, private sector, education and civil society along with people centric development was identified as a prime towards achieving knowledge economy and information society. As a result, NesPA may be seen as a developmental lens through which the process of e-Skilling may be adequately focused to guide the development of knowledge economy and information society.

Study Procedures

The procedures of this research case study comprise of identification of the study participants, pilot training execution and empirical measurement of e-skills levels. The Evidence Centered Design (ECD) principles were used to capture the intricacies of empirically measuring e-skills levels of CDWs. The ECD principles have prompted the stakeholders of e-skills agenda to carefully

cogitate on critical decision attributes such as the purpose of the e-Skilling, the fundamental assumptions about the citizens to be e-skilled, the intended claims to be deduced from the outcomes of the e-Skilling and the evidence to support claims of success. The NesPA 2010 and NesPA 2013 documents provide the details of these important decision attributes. The ECD enables an evidence based analysis to be performed that addresses the germane issues of measurement validity and generalization of findings. The construction of a measurement procedure within the ECD framework allows for an appropriate choice of methodologies, identification of study participants and reporting protocols.

Study Participants

The population of the study participants of this research case study is the entire 469 CDWs from the KwaZulu-Natal (KZN) province in South Africa. The CDWs from KZN participated in this research case study because of their practitioner roles. The provincial manager, the senior manager at COGTA as well as representatives of e-SI and KZN Co-lab were directly responsible for coordinating the success of this project. In particular, the provincial manager and the senior manager at COGTA coordinated the participation of CDWs in the research project.

The 327 (70%) CDWs provided the pretest data and 189 (81%) of the 234 CDWs who participated in an e-skills development training provided the posttest data. Maintaining sample sizes of 327 of about 70% of the total CDWs in the KZN province and 189 of about 81% of 234 CDWs who participated in the pilot training, allow for the use of inferential analysis. This research case study was expected to be extended to the Northern Cape province of South Africa. The extension of the research case study to CDWs from other provinces is appropriate because the group largely consists of institutions with similar visions and missions.

Pilot Training

In this research case study, we have considered e-skills development training as an important principle because someone contemplating embarking on an evidence based study must have a conception of the intended recipients and should be able to provide an adequate avenue for knowledge sharing. In addition, this could ensure the deduction of coherent findings regarding the determination and the validation of e-skills levels of CDWs. The pilot training was initiated by line managers in government who identified the need to train CDWs in the use of ICT. The e-SI tasked the KZN e-skills Co-lab at Durban University of Technology (DUT) with the responsibility of implementing the pilot training project. In addition, the Co-lab was tasked to research on the effectiveness of the pilot training. The functions of CDWs perfectly align with service delivery, which is the thematic area of the Co-lab – "e-enablement of government services". Moreover, the DUT is one of the partners in the e-SI collaboration network.

The pilot training was optimally designed using the internet technology to enable the CDWs to access learning materials from every community in the KZN province. The use of the internet technology minimized mobility or flow of people to attend the training at a central location. The pilot training was therefore executed through a teaching and learning technology that CDWs could access on their laptops at different locations. Moreover, the design of the pilot training allowed for consistent delivery of training and learning as well as reduction of device related issues as individuals were able to access internet by bringing their own devices. The execution of the pilot training spanned two weeks, 4 days per week for each group of CDWs and there were two groups of CDWs who were successfully trained. The training periods translated to a total of 5 hours per day that resulted in 20 hours effective contacts per group. The training ran across 11 centers in 8 districts in the KZN province. In total, 234 (49%) of the envisaged 476 CDWs were successfully trained, 3 coordinators and 12 facilitators attended the training from 28 municipalities across 8 districts of the province. The training lessons were accessed online under the guid-

ance of a facilitator at each training center. The facilitators were individual ICT experts who facilitated the training and kept CDWs on task.

Training facility

The training centers were inspected before the training actually started in order to ensure the availability of adequate training and learning facilities. The Blackboard internet technology platform was used for the training (Figure 1). This platform is a Virtual teaching and Learning Environment (VLE) that provides an internet access to learning materials and lessons. Blackboard is one of the leading commercial internet-based teaching and learning platform developed by the Blackboard Inc, which is based in America. Blackboard is widely used by many universities across America, Europe and Australia to provide a web-based learning experience, an assessment tool and a submission facility for users. Blackboard is a platform adopted by the Durban University of Technology (DUT) to support modern teaching and learning pedagogies. The technology provides an innovative alternative to the conventional content based teaching and learning. Blackboard is beneficial to CDWs because it eliminates geographical boundaries, saves mobility costs, accommodates multiple learning styles, leverages limited teaching resources as well as scales information and knowledge.

Figure 1: The training lessons delivered in the Blackboard environment

The CDWs were given continual access to the online training materials and lessons for at least one year of post training to encourage long-life learning and to enable quick references to learning materials. In addition to the training lessons and materials available within the Blackboard, the facilitators had the training lessons and materials on their Universal Serial Buses (USBs) to provide an alternative in case internet connectivity becomes a problem at a training center. The problem of internet connectivity was experienced at some training centers and it prevented the CDWs from the affected centers to be familiarized with Blackboard. The facilitators had to rely on the courseware saved on their USBs to ensure the smooth running of the training and learning.

Training expectations

The coordinators who were responsible for coordinating the activities of CDWs reported before the start of the training that CDWs have the expectations of being taught. The coordinators further

mentioned that most of the CDWs were at a low level of e-skills while some of them may be at a higher level of e-skills. The training expectations of CDWs were extensively discussed at a number of planning meetings. The facilitators were encouraged to use a better training and learning pedagogy to help the CDWs to follow the step-by-step instructions. In order to adequately accommodate the diversity in the e-skills levels of CDWs, it was agreed to offer a range of e-skills development training from the basic word processing to a more advanced internet application.

In order to adequately address the training expectations of CDWs, an interactive studio based training and learning pedagogy was implemented. The studio pedagogy guided the CDWs through a holistic process of e-skills development, while concurrently training them in the use of ICT. The studio environment enabled a small group of CDWs to work on the class activities while receiving continual guidance from a facilitator. The studio pedagogy was implemented in the Blackboard environment to incorporate step-by-step text and graphical instructions (Figure 2). The text and graphical instructions were preferred to the video instructions because video lessons would be more difficult to logically guide the CDWs. In addition, the video instructions may not accurately accommodate the cultural diversity, listening skill and writing skill of the individual CDWs. These important decision criteria have influenced our choice of text and graphical based instruction delivery using a studio pedagogy to stimulate active learning amongst CDWs in the Blackboard environment.

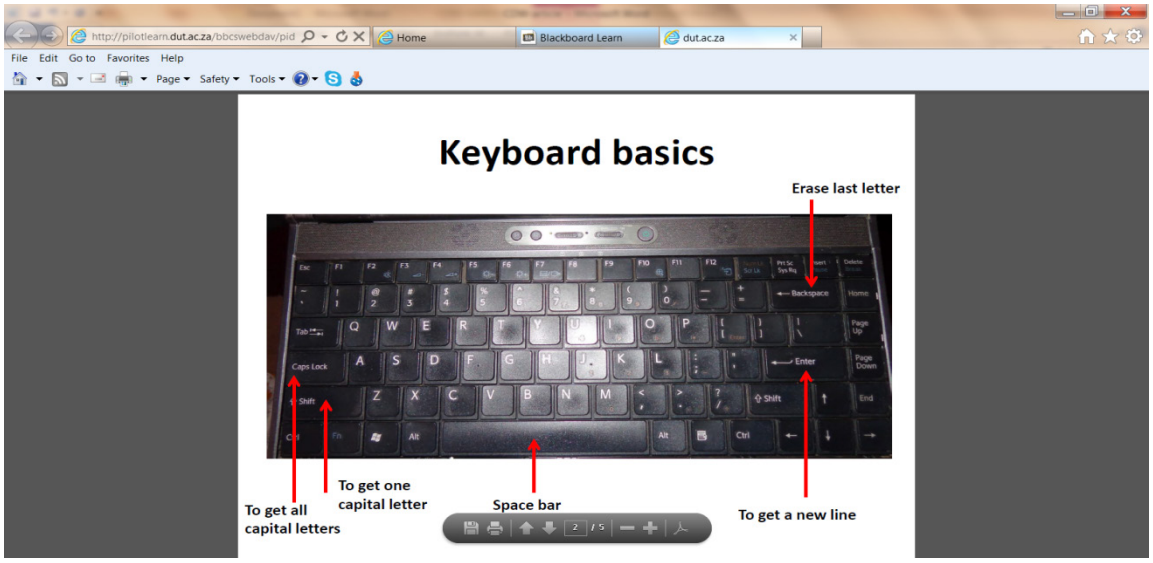

Figure 2: Text and graphical introductory lesson to identify the functions of different keys on the keyboard

The training program was organized into 15 different lessons, ranging from very basic to a more challenging ICT application. The CDWs were at liberty to select a particular lesson that suits their competency levels and relevant to their workplace (Figure 3). This freedom of choice promotes personalized learning. The concept of personalization refers to a strategy to achieve learning goals for an individual learner. The facilitators reported that CDWs were able to quickly adapt to work on various aspects of the lessons they found relevant to their workplace. The general feedbacks provided in the satisfaction survey and by the word of mouth from individual CDWs were impressive as they unanimously demanded for a follow-up training. The feedbacks generally indicated the effectiveness and the acceptance of the pilot e-skills development training.

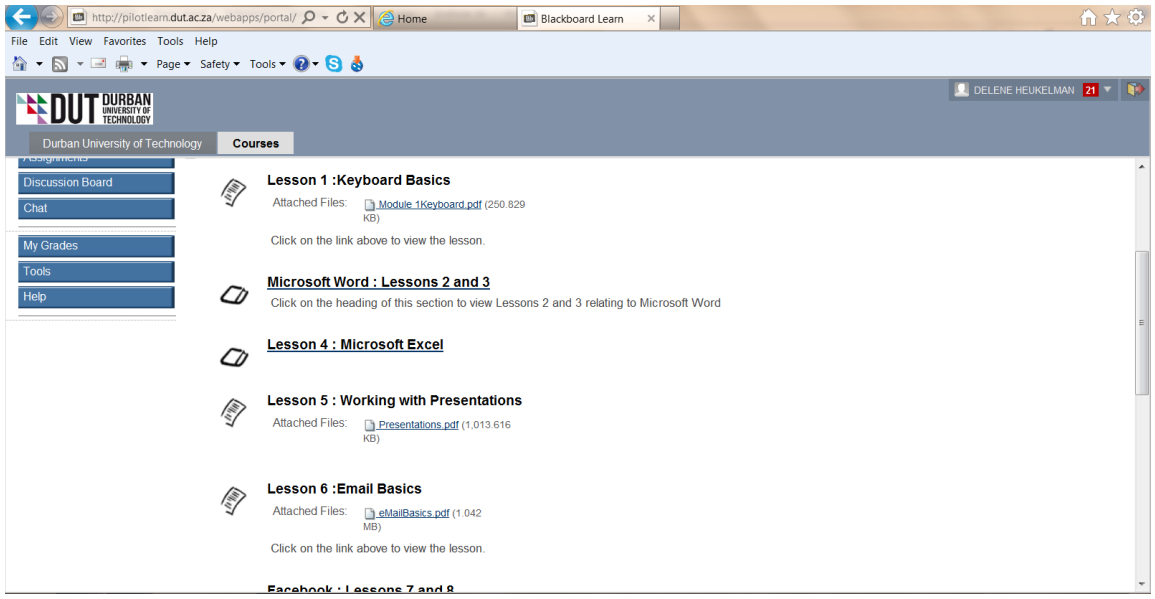

Figure 3: List of lessons organized in order of complexity with lesson 1 as basic and lesson 15 as a more advanced

Training lessons

The training program was organized into fifteen different lessons that were developed to incorporate word processing, spreadsheet application, Google Map, search engine, Dropbox and community Facebook. Each lesson had a set of exercises to be completed by the CDWs who were expected to submit a minimum of eight exercises online. The CDWs were encouraged to provide more of their job related practical samples that were developed into the training lessons and incorporated into the Blackboard. The fifteen sample lessons developed for CDWs are discussed as follows:

a) Lesson 1 (Keyboard) - this is an introductory lesson to help CDWs identify the functions of different keys on the keyboard system.
b) Lesson 2 (Word menu) - the menu system is an important stepping stone for many ICT applications. If a menu system is well taught, many CDWs could find it easy to use different applications. This lesson introduces the concept of a menu system in a systematic way.
c) Lesson 3 (Word tables) - tables are used very often in various ways in order to effectively manage document. This lesson shows a step-by-step guide on how to create tables within a word document.
d) Lesson 4 (Spreadsheet) - many of the report templates that are used by CDWs are in the spreadsheet format. It was therefore important to teach the concepts of formulae, graphs and data analysis using a spreadsheet system. This lesson guides CDWs to use a spreadsheet system for data analysis.
e) Lesson 5 (Presentations) - CDWs are faced with the task of frequently disseminating information within their communities and they are therefore required to speak to groups of people. The use of a presentation software could lead to a better understanding of how to present information. This lesson covers how to create “good” presentations in a presentation system.
f) Lesson 6 (Emails) - even though CDWs have the email addresses of their workplace as “xxxx@cocta”, having a private email address would allow CDWs to experiment with emails. Moreover, it would contribute towards making ICT part of everyday life of

CDWs. This lesson explains how to create email addresses as well as send and receive emails.

g) Lesson 7 (Facebook) - being able to adequately use Facebook would lead to user confidence with social network systems. Some aspects such as privacy and ethics could be easily introduced and illustrated using a network system such as Facebook. This lesson explains how to create Facebook accounts and to establish communication with people using Facebook.
h) Lesson 8 (Community Facebook) - once a Facebook page for an individual has been created, it could serve as an effective communication tool within a community. Facebook is widely available on many cellphones and if CDWs could create a Facebook page for their communities, they may find greater interaction taking place within the communities. This lesson explains how to use Facebook for interacting with people within the communities.
i) Lesson 9 (Dropbox) - the concept of cloud computing and using an application such as Dropbox to access information from anywhere is emerging for future ICT applications. This lesson, therefore explains how to create and use a Dropbox to store and exchange data.
j) Lesson 10 (Internet search) - CDWs were introduced to some advanced searching techniques. They (CDWs) were encouraged to search for topics such as "government department sites", "awareness and campaigns" and topics of interest to their communities. This lesson explains how search engines could be effectively used to discover and access information on the internet.
k) Lesson 11 (More than searching) - the integrated environment offered by the Google search engine is a powerful tool that was introduced to CDWs. Document sharing could effectively be used by CDWs to facilitate interactivity. The Google drive was also covered in this lesson and CDWs found the integrated environment of Google more appealing.
l) Lesson 12 (RSS feeds and web technology) - many websites show the Rich Site Summary (RSS) icon to indicate that RSS feeds are available. The various uses of RSS were explained in this lesson, but CDWs did not appear to think that RSS feed was of much value to them.
m) Lesson 13 (VOIP and IM) - the concept of using applications such as Skype, WhatsApp and related technologies to communicate at a cheaper price rate was discussed in this lesson. The possibility of conference calls using these technologies in place of face-to-face meetings was introduced in this lesson.
n) Lesson 14 (Spreadsheet charts) - during the delivery of this training, some CDWs expressed interest in spreadsheet charts. This lesson was therefore added to the list of lessons to introduce advanced spreadsheet features.
o) Lesson 15 (Google maps) - while discussing some of their job requirements, the CDWs identified their inability to use ICT to locate areas. Consequently, a lesson on how to use the Google maps engine to locate areas was introduced. This lesson demonstrates the various applications of Google maps.

Training pedagogy

The studio pedagogy was implemented in a Blackboard environment and used to facilitate self-directed learning amongst CDWs. Hands-on practical work was promoted because it is often said that the best way to learn is by doing. Moreover, people say actions speak louder than voice. The CDWs completed different practical exercises that were graded online and the final grade obtained was reflected in the certificate of attendance. If CDWs managed to complete the exercises for a lesson, it means they have worked with different applications which is what is being promoted. The successful completion of certain exercises by a CDW gave an indication that a

certain level of work was done using ICT and the CDW should be rewarded accordingly. The rule of thumb for the merit award is simply as follows. Each CDW was expected to submit a minimum of eight exercises for which a pass (50%) was awarded. An overall pass mark of 65% was awarded for correct answers to the exercises. A distinction mark was awarded for a submission of at least ten exercises. However, a fail mark was awarded for a submission of less than eight exercises.

The pilot training was logically conducted in a studio based Blackboard environment to deliver class activities such as lessons, exercises, assignments, tasks or projects between November – December 2013 as follows:

a) The CDWs logged into the Blackboard environment from their laptops to complete class activities. Those who have not completed a pretest assessment were requested to do so by answering a set of questions designed to tap on their ability to apply ICT in the workplace.
b) The CDWs collaboratively work in small groups of about 2-4 persons to cooperatively develop their e-skills. The CDWs were at liberty to freely select those colleagues, they are comfortable working with, as a team. However, a conscious decision was taken not to provide CDWs with printed materials to guide class activities, thereby encouraging the direct use of e-skills to access those materials online.
c) The Blackboard provides step-by-step instructions to CDWs in order to facilitate active learning. The instructor provides guidance on demand by serving as on-hand resources for CDWs to use for class activities. This mechanism minimizes unnecessary lectures and paves the way for a more productive interaction between CDWs and the instructor.
d) The class activities build on each other in tandem to provide a dynamic learning environment that emphasizes on personal skills development, instead of content learning. Each class lesson was paired with a set of exercises that emphasis on the applications of ICT in the workplace. All class exercises were completed and submitted online through Blackboard to encourage e-skills development. The exercises were part of the step-by-step instructions for each e-skills category. There was no time limit to complete an exercise, but an exercise session is not more than one hour to avoid loss of concentration.
e) The CDWs were at liberty to work on class lessons they found most relevant to their workplace in order to ensure a more progressive path. The emphasis was more on the mastery of work-related e-skills and not on passing an examination. A particular attention was given to the ability of CDWs to navigate through the list of lessons and to adequately provide responses.
f) The CDWs were required to complete self-report posttest measures of their e-skills levels and self-report measures of their satisfaction of the pilot training. These measures were designed to respectively tap on the cognitive skills and affective behaviors of CDWs. The posttest was implemented about two months after the completion of the pilot training to allow for sufficient time to enable CDWs to practically test the applicability of the acquired e-skills at the workplace.

Empirical e-Skills Measurement

The policymakers need some kind of evidence-based measures obtained from a rigorous quantitative measurement in order to accurately determine the impact of a development initiative. This measurement is particularly important because it provides a barometer for policymakers to judge the fulfillment of their responsibilities and to determine the extent that their goals have been achieved. The evidence based measurement results should ideally inform policymakers about the success of the initiative or the policy, convince them to support the initiative, provide a basis to

refine existing initiative and justify the appropriateness of budget allocation to implement the initiative.

The e-skills levels were empirically measured using self-report measures that CDWs responded to before the training (pretest) and after the training (posttest). The differences in the pretest and the posttest results should ideally reflect whether or not e-skills development had occurred as a result of the pilot training. The pretest-posttest method enables the real-time monitoring and evaluation of the impact of the pilot training. The e-skills can be categorized into five main categories in order to accurately measure them. The "report writing" category, for instance, has a measure of "I have the skills to create a well formatted human settlement report using a word processor" in the pretest measurement instrument (Table 1). This measure is synonymously written for the posttest measure as "My skills to create a well formatted human settlement report using a word processor has improved as a result of the e-skills training development" (Table 2). These categories of e-skills are briefly discussed as follows.

a) Report writing – the ability to use word processing software to write well formatted reports.
b) Presentation design – the ability to design attractive presentations using a presentation software.
c) Internet search - the ability to use a search engine to find relevant information on the internet.
d) Data management – the ability to use a spreadsheet software to efficiently analyze data.
e) Information communication – the ability to use a communication software to interact with people in an appropriate way.

Table 1: Self-report pretest measures with their categories

Code	Item Category versus Item Measure
	REPORT WRITING
Q25	I have the skills to create a well formatted human settlement report using a word processor.
Q26	I have the skills to report poverty issues to my information manager using a document template.
	PRESENTATION DESIGN
Q27	I have the skills to create and convey information on HIV/AIDS awareness using an electronic presentation software.
Q28	I have the skills to create suitable posters to manage utilities usages, human right and civil responsibilities issues using a presentation software.
	INTERNET SEARCH
Q29	I have the skills to discover crop management information from a government portal or a website using a search engine.
Q30	I have the skills to access crop market prices from a government portal or a website using a search engine.
Q31	I have the skills to search for supply chain tender in a government portal or a website using a search engine.
Q32	I have the skills to find funding opportunities, donors and development agencies in a government portal or a website using a search engine.
Q33	I have the skills to access and download government agency related information and forms using a government portal or a website.

Q34	I have the skills to collect information using a Really Simple Syndication (RSS) feeds reader.
Q35	I have the skills in accessing government information and services (health, agriculture, education, funding, aviation, tourism) using a search engine.
	DATA MANAGEMENT
Q36	I have the skills to analyze data using a spreadsheet software.
Q37	I have the skills to set up a financial budget using an electronic spreadsheet.
Q38	I have the skills to capture associated data in a structured format using electronic media.
	INFORMATION COMMUNICATION
Q39	I have the skills to facilitate mobile interaction between community members and government representatives using social media such as SMS, email and Twitter.
Q40	I have the skills to synchronize calendars on mobile and desktop devices using electronic media.
Q41	I have the skills to set up a meeting across and within different spheres of government using electronic media.
Q42	I have the skills to set up a group on an email account using electronic media.
Q43	I have the skills to create new network collaboration using social media.

Table 2: Self-report posttest measures with their categories

Code	Item Category versus Item Measure
	REPORT WRITING
Q25	My skills to create a well formatted human settlement report using a word processor has improved as a result of the e-skills development training.
Q26	My skills to report poverty issues to my information manager using a document template has improved as a result of the e-skills development training.
	PRESENTATION DESIGN
Q27	My skills to create and convey information on HIV/AIDS awareness using an electronic presentation software has improved as a result of the e-skills development training.
Q28	My skills to create suitable posters to manage utilities usages, human right and civil responsibilities issues using a presentation software has improved as a result of the e-skills development training.
	INTERNET SEARCH
Q29	My skills to discover crop management information from a government portal or a website using a search engine has improved as a result of the e-skills development training.
Q30	My skills to access crop market prices from a government portal or a website using a search engine has improved as a result of the e-skills development training.
Q31	My skills to search for supply chain tender in a government portal or a website using a search engine has improved as a result of the e-skills development training.
Q32	My skills to find funding opportunities, donors and development agencies in a government portal or a website using a search engine has improved as a result of the e-skills development training.
Q33	My skills to access and download government agency related information and forms using a government portal or a website has improved as a result of the e-skills development training.

Q34	My skills to collect information using a Really Simple Syndication (RSS) feeds reader has improved as a result of the e-skills development training.
Q35	My skills in accessing government information and services (health, agriculture, education, funding, aviation, tourism) using a search engine has improved as a result of the e-skills development training.
	DATA MANAGEMENT
Q36	My skills to analyze data using a spreadsheet software has improved as a result of the e-skills development training.
Q37	My skills to set up a financial budget using an electronic spreadsheet has improved as a result of the e-skills development training.
Q38	My skills to capture associated data in a structured format using electronic media has improved as a result of the e-skills development training.
	INFORMATION COMMUNICATION
Q39	My skills to facilitate mobile interaction between community members and government representatives using social media such as SMS, email and Twitter has improved as a result of the e-skills training program.
Q40	My skills to synchronize calendars on mobile and desktop devices using electronic media has improved as a result of the e-skills development training.
Q41	My skills to set up a meeting across and within different spheres of government using electronic media has improved as a result of the e-skills development training.
Q42	My skills to set up a group on an email account using electronic media has improved as a result of the e-skills development training.
Q43	My skills to create new network collaboration using social media has improved as a result of the e-skills development training.

Measurement theory

The partial credit model, which is based on the Item Response Theory (IRT) implemented in the Item And Test Analysis (IATA) software was used to empirically estimate the IRT parameters from the responses provided by CDWs. The IATA is a software package for the analysis of psychometric and educational assessment data (Cartwright, 2013). Briefly in the form of an introduction, the IRT, which is sometimes called latent trait model provides a model based linkage between responses such as questions, items, tests, or measures and latent traits such as e-skills, abilities, proficiencies or competences assessed by a test or a scale. In general, IRT is a probabilistic model that explains the response that a person gives to an item. The theory postulates that the probability that a random person with a given ability answers a random item with a difficulty level correctly is conditioned on the ability of the person and the item difficulty. On one hand, a person with a high ability in a given field of study will probably get an easy question correctly. On the other hand, a person with a low ability will always get a difficult question incorrect.

The Classical Test Theory (CTT) was operationally used prior to the development of IRT, to estimate the score that an individual obtains on a test. The palpable difference is that CTT considers a test as the unit of analysis, but IRT analysis focuses on the test item. The apparent problem with CTT is that test items may significantly vary in terms of their difficulty and discrimination power. The result of the scores produced by CTT methods may therefore present inaccuracies that can be avoided using IRT methods. The IRT effectively solved the problems facing CTT methods by focusing on the item as the unit of analysis. In the simplest case of IRT application, data are comprised of a sample of individuals who dichotomously responded to a set of tests or scale items. The goal is to estimate the characteristics of the items and the individuals. The partial credit model, which is also called the graded-response items, are the polytomous test items that have more

than one score value. The analysis of a partial credit item assumes that an examinee who has achieved a particular item score has also mastered whatever level of skill that is associated with a lower score on that item. That is, if each score is treated as a separate test item, then an examinee with a high partial credit score has also effectively performed correctly on the lower credit scores. The dichotomous response is therefore a special case of polytomous response and results of dichotomous item response models can be extended to polytomous item response models.

Usefulness of measurement theory

The CTT/IRT is useful if the data fit the theoretical model and the primary indicator of an item quality is the discrimination power. The important classical item statistics that are good indicators of the usefulness of an item are – the item discrimination index ("Discr"), the point-biserial correlation (PBis) and the item facility ("PVal") - also sometimes called the item difficulty.

a) The item discrimination indicates the extent to which an individual item measures what the whole test is measuring. If all examinees produce the same response to an item, regardless of their levels of proficiency, the item cannot discriminate between the different levels of proficiency of the examinee. The high positive value of discrimination, which should be greater than 0.2 indicates that the item is good at discriminating between high ability and low ability examinees.
b) The point-biserial correlation relates the scores that examinees obtain on a given item and the total scores the examinees obtain on the overall test. A large positive value of point-biserial correlation, which should be greater than 0.2 indicates that examinees with high scores on the overall test indicate the item rightly answered and examinees with low scores on the overall test indicate the item wrongly answered.
c) The item facility whose value ranges between 0 and 1 describes how easy an item is for the given sample with larger values indicating an easier test item. The value of 0 indicates that no examinees responded correctly and a value of 1 indicates all examinees responded correctly.

The CTT parameters, within the IRT framework correspond to a-parameter, b-parameter and c-parameter. These IRT parameters are discussed as follows.

a) The a-parameter represents item discrimination. The larger the value of this parameter, the steeper the slope of the Item Response Function (IRF) that is sometimes called the Item Characteristic Curve (ICC). This also implies the more an item discriminates between the examinees with high ability and low ability. The IRF is the plot of the probability of a correct response to an item as a function of the ability and it represents the relationship between an item and the overall test performance.
b) The b-parameter represents the item difficulty. The values of this parameter are usually scaled as z-scores so that an extreme negative value such as -3 would correspond to very easy item, the value of 0 would be regarded as moderate difficulty and an extreme positive value such as +3 would be regarded as a very difficult item.
c) The c-parameter represents a pseudo-guessing parameter that shows the estimate that an examinee who knows nothing will not always select the correct answer for a specific item.

The IRF and the distractor table are used in addition to CTT/IRT statistical parameters to determine the relative usefulness of different test items. The distractor analysis is used to determine the errors arising from the poor wording, confusing instruction, sampling error and miskeying of items. The following guideline was used in this research case study to identify a set of useful items with the aid of the IATA software:

a) A useful item will have a strong relationship with e-skills as indicated by an IRF that has a strong S-shape because of high values of the steeper slope parameter.
b) The correct column option on the distractor table, which is denoted by the asterisk (*), should have a high percentage for the high group and successively lower percentages for the medium and the low groups.
c) For the low skilled group in the distractor table, the percentage of examinees choosing the correct option should be lower than the percentage of those examinees choosing any one of the other options.
d) For the highly skilled group in the distractor table, the percentage of examinees choosing the correct option should be higher than the percentage of examinees choosing any one of the other options.

Measurement of e-skills levels

The maximum likelihood algorithms are naturally used for ability or skill estimation in the application of the item response theory. The maximum likelihood algorithm considered in this research case study is an iterative process that begins with a priori value of e-skills, giving the values of item parameters and response pattern of an examinee (CDW in this research case study). The response pattern is usually a sequence of Bernoulli values, so for non-Bernoulli responses, a suitable algorithm has to be applied to transform the responses to Bernoulli. The a priori e-skills and the item response parameters are used to compute the probability of the response pattern of the examinee. The adjustment to the estimated e-skills is then obtained that improves the agreement of the computed probabilities with the response pattern of the examinee. This process is repeated until the adjustment in the e-skills value becomes sufficiently small that the observed change in the estimated e-skills is negligible.

The mathematical formulation of this iterative process (Baker, 1992) as implemented in this research case study using the C++ programming language is given as follows:

$$\hat{\theta}_{i,s+1} = \hat{\theta}_{i,s} + \frac{\sum_{j=1}^{n} a_j (r_{i,j} - p(\hat{\theta}_{i,s} \mid a_j, b_j, c_j))}{\sum_{j=1}^{n} a_j^2 p(\hat{\theta}_{i,s} \mid a_j, b_j, c_j)(1 - p(\hat{\theta}_{i,s} \mid a_j, b_j, c_j))} \quad (1)$$

Where:

a) $\theta_{i,s}$ is the estimated e-skills of the ith CDW within the sth iteration, 1=1,2, ..., m.
b) a_j is the discrimination parameter of the jth item, j=1,2, ..., n.
c) b_j is the difficulty parameter of the jth item.
d) c_j is the pseudo-guessing parameter for the jth item.
e) $r_{i,j}$ is the response made by the ith examinee to the jth item.
f) $p(\hat{\theta}_{i,s} \mid a_j, b_j, c_j)$ is the probability of a correct response to the jth item, given the item parameters at the e-skills of the ith CDW within sth iteration.

The probability of a correct response to the jth item is given according to the following logistic function:

$$p(\hat{\theta}_{i,s} \mid a_j, b_j, c_j) = c_j + \frac{1 - c_j}{1 + \exp(-a_j(\hat{\theta}_{i,s} - b_j))} \quad (2)$$

In this research case study, e-skills of all CDWs were distributed over a range of e-skills levels on a specified e-skills scale, so that all CDWs within a given point on the e-skills scale have the same e-skills level. The e-skills scale is a 7-point Likert scale, where major points on the scale are interpreted as follows. The point 1 means extremely unskillful, 2 means very unskillful, 3 means somewhat unskillful, 4 means moderately skillful, 5 means somewhat skillful, 6 means very skillful and 7 means extremely skillful. This categorization has enabled us to identify a set of CDWs with similar needs, for example, those who required further training on a particular topic they found hard to master.

Measurement instrument

The need for relational analysis of data has led to the choice of using a measurement instrument to solicit for forty three distinctive self-report measures. The first twenty four measures were used to collect social data about CDWs who participated in this research case study. The remaining nineteen measures which are categorized into five categories were used to collect data that were used to empirically measure the e-skills levels of CDWs. The different aspects of the measurement form the basis for the construction of the forty three self-report measures. The self-report measure is often judged in the literature as the most cost-effective and valid means of collecting personal information about people (Baker & Brandon, 1990, Glasgow, et al. 2005). The measurement instrument of this research case study was designed to collect self-report measures because asking a set of good questions would afford the CDWs the opportunity for deeper thinking. In addition, these measures provide the training facilitators with a significant insight into the extent and the depth of e-skills levels at prior and post training regimes.

The ability of CDWs to accurately respond to a measurable item at the established scores was measured by having them to use a five-point Likert scale with the rubrics shown in Table 1 and Table 2. The high response corresponding to a score of 5 indicates “excellent skills”, the low response that corresponds to a score of 1 indicates “no skills”. Moreover, the intermediate response corresponding to a score of 2 indicates “limited skills”, a score of 3 indicates “average skills” and a score of 4 indicates “good skills”. It should be noted that these responses were not the true reflection of the e-skills levels of CDWs because they were subjective self evaluation ratings provided by individuals CDWs. The estimates of the true e-skills levels of CDWs were calculated by the maximum likelihood mathematical model given by equation (1), taking into cognizance the IRT parameters mined from the responses of CDWs.

The design of the self-report data accompanying the e-skills measurement allowed cognitive-affective variables to be recorded and displayed in a spreadsheet relational data format. The cognitive-affective personality system proposed by Mischel & Shoda holds promise for an e-skills performance based measurement (Mischel & Shoda, 1995). On one hand, the latent traits that correspond to the e-skills of CDWs may be understood to be a cognitive function. On the other hand, the inclusion of affectionate measures of performance as recognized in the field of educational assessment, evaluation and research, contribute to the measurement that reveals the behavior of CDWs towards the pilot training. The affectionate self-report measures were 35 items incorporated into the measurement model of this research case study using a five-point Likert scale. The measures were informed by the concept of training service satisfaction that would yield a more complete understanding of self-confidence of CDWs to use ICT to enhance the effectiveness of service delivery. Moreover, it tells us more about the perceptions of CDWs on the pilot training and their ability to achieve proficiency in ICT. The affective measurement model, although not discussed in this paper was based on customer service satisfaction metrics of satisfaction, complaint, loyalty, image, perceived value, perceived quality and training expectation (Wisniewski, 2001; Turkyllmaz & Ozkan, 2007; Singh & Khanduja, 2010; Yoon & Bae, 2010; Zaim, et al., 2010).

Validity of measurement instrument

In an attempt to explore a set of job related metrics for the measurement of e-skills levels, we engaged in an extensive scoping review of the issues surrounding data validation. The concept of data validity can be understood from the literature to mean an integrated judgment of the degree to which an empirical evidence and theoretical rationales support the appropriateness of inferences, propositions or conclusions (Cronbach, 1955; Messick, 1980; Kane, 1992; Cook. & Beckman, 2006; Gomez & Elliot, 2013). The reliability of a measurement is a particular type of validity – which is the extent that a measurement consistently gives the same result on different occasions. The significance of a measurement reliability is to obtain a standard index to evaluate the validity of the measurement.

The validity of a measurement scale can be influenced by diverse factors among which are ability of people being measured, the method of measurement (pretest-posttest posttest-pretest, quasi design), length of the measurement and structure of reporting. The validity of a pretest-posttest can be compromised because of pretest sensitivity and response shift bias. The literature on validity theory has suggested certain widely used solutions to minimize the effects of pretest sensitivity and response shift bias. These solutions are to pay attention to the wordings of the measurement instrument, the retrospective pretest (posttest, before pretest) and the control group quasi experimental design. The first option is especially appealing in the research case study at hand because the e-skills measurement instrument is particularly inspired by the application of ICT to the workplace. This implies that the measurement instrument was designed to measure the specific e-skills relevant to the daily activities of CDWs, thereby improving measurement validity.

Results and Discussion

The pretest and posttest data formatted in Microsoft Excel format were uploaded to the IATA software for the estimation of IRT parameters. These parameters were supplied into a maximum likelihood algorithm for the determination of the e-skills levels of CDWs. The important results of this research case study and their discussions are presented in this section under the main headings of descriptive statistics, testing for validity and comparing e-skills levels.

Descriptive Statistics

The Microsoft Excel software was used for the descriptive analysis of frequency, mean, standard deviation, minimum and maximum values of responses.

Participant demographics

The statistics of the pretest data revealed that four coordinators, who were responsible for coordinating the activities of CDWs, participated in the research case study. The pretest sampling plan contained an uneven gender division of 206 female CDWs and 121 male CDWs. This uneven gender sample reflects the dominance of the female population over the male population in South Africa. The Statistics South Africa (Stats SA) 2013 estimated the mid-year population at 52.98 million with approximately 51% of the population was found to be female. The majority of the CDWs (262) work in rural disadvantaged areas, 53 of them work in semi-urban marginalized areas and 12 of them work in urban city advantaged areas.

Educational background

The 327 CDWs who participated in the pretest experiment had educational backgrounds in Grade 12, post-grade 12 education, NPDE and N6 Certificate. Specifically, 189 CDWs had Grade 12 qualification, 136 had post-grade 12 education, 1 had PDE and 1 had N6 Certificate. There were 192 CDWs who had some form of formal training in the use of computer systems and related

applications. There were 137 CDWs who had no formal computer training skills. There were 16 CDWs who claimed that they have "very competent" level of skills in using computer systems, 158 of them claimed to have "average" competence level, 134 of them claimed to have "low level of competence" and 19 of them claimed to have never used a computer system. It should be noted that this result included those CDWs who had no formal training in the use of computer systems, but may have had informal training.

Table 3 shows the number of CDWs who have competence using a particular software application on their computing devices - desktop computer, laptop and Smartphone. The majority (274) of the CDWs had used email applications, 201 of them had used word processing and 34 of them had never used any application. Table 4 shows the number of CDWs who have competence using a particular software application on their Cellphones or Smartphones. The majority (300) of the CDWs had used WhatsApp, but only 5 of the CDWs indicated that they had not used any cellphone. It is interesting to see that many CDWs had used Blackberry Messenger (BBM) and Google – which are both communication software that CDWs found useful to connect with stakeholders. The following additional educational information was collected from the participating CDWs:

a) The CDWs, when asked what they expected to gain from the pilot e-skills training. They mentioned that they expected to gain knowledge, to be able to write reports using computers, access computers, access the internet and they wanted to acquire computer and internet skills.

b) The CDWs when asked to state why they are participating in the pilot e-skills training, the majority of them wanted to acquire ICT knowledge (160 of them) while 58 of them wanted to acquire ICT skills (e-skills). The others simply said they wanted to gain more knowledge, improve their knowledge and gain computer skills. The summary of the need requirements of the CDWs is that many of them wanted to gain knowledge and skills pertaining to ICT.

Table 3: Number of CDWs who have used a given software application

Software Application	Response
Word processor	201
Presentation software	84
Spreadsheet	90
Email	274
Management information system	26
Other	35
I don't use any	34

Table 4: Number of CDWs who have Competence using Software Applications on their Cellphones or Smartphones

Software Application	Response
WhatsApp	300
Facebook	194
Twitter	46
Blackberry Messenger (BBM)	281
Google	237
Other	34
I don't use any	5

Job requirements

The job requirement information has to do with the daily tasks performed by the CDWs that require using ICT. The majority (221) of CDWs indicated that they phone people daily. Surprisingly, among those CDWs who phone people, at least monthly, 231 of them used ICT, but another 96 of them never used ICT besides the ordinary phones they used for communication purpose. It is interesting to discover that phoning people, providing information to individuals, searching the internet for information and sending messages to people of different groups are the predominant tasks of CDWs who participated in this research case study (Table 5). The majority (149) of CDWs indicated that they spent more than 50% of their time per day writing reports and 118 of them attended meetings (Table 6). The following additional job requirements information was collected from the participating CDWs:

a) The CDWs when asked to describe in a few words the specific area of job responsibility, the majority of them claimed that they assist in the development of the community by disseminating information, facilitating communication, coordinating community activities, relating government to communities and communicating government services to the communities.
b) The CDWs when asked to describe in a few words how the delivery of public services to communities has been improved in the last three years. They generally mentioned that there was improved access to government information and improved community development – in terms of road rehabilitation, provisioning of sanitation, houses, clean water, stable electricity and free basic services. In addition, they mentioned that there were skills development and a reduction in long queues often experienced in government departments.
c) The CDWs when asked to say what they think would be the benefits of using ICT in their jobs. The majority of them responded that ICT makes the job easier, improves communication, facilitates data capturing, supports report writing and improves job skills. In addition, they mentioned that ICT improves quality of work, provides easy access to relevant information, enables someone to acquire new knowledge and to develop one's skills.

Table 5: Frequency of tasks performed by CDWs using ICT

Task Performed by CDWs	Daily	Weekly	Monthly	Never Performed Task	Use ICT
Write reports	12	41	249	25	307
Email people	88	117	71	51	327
Provide information to individuals	181	64	36	46	275
Talk to groups of people	100	134	45	48	252
Attend meetings	41	205	43	38	232
Phone people	221	43	23	40	231
Search for information	169	79	33	46	284
Provide forms for people to complete	43	97	117	70	212
SMS groups of people	115	108	54	50	251
Submit a budget or financial statement	25	23	97	182	48

Table 6: Percentage of time spent per day on tasks

Task Performed by CDWs	Less than 10%	10-30%	30-50%	50% and more	No Response
Write reports	25	56	83	149	14
Email people	81	68	101	54	23
Provide information to individuals	36	75	74	92	30
Talk to groups of people	55	67	91	86	28
Attend meetings	27	46	105	118	31
Phone people	60	69	77	97	24
Search for information	30	73	108	97	19
Provide forms for people to complete	81	75	78	57	36
SMS groups of people	72	82	78	70	25
Submit a budget or financial statement	150	31	13	16	117

Technology infrastructure

The information collected on technology infrastructure includes computer devices and software applications often used by CDWs. The majority (312) of the CDWs had access to laptops, 244 of them had access to Smartphones, but only 52 of them had access to desktop computers (Table 7). The huge percentage of CDWs had access to laptops because recently the KZN province provided the CDWs with laptops and USB internet modems to enhance their ability to use ICT for service delivery. The majority (289) of the CDWs had access to the internet, but only 38 of CDWs had no opportunity to access the internet. The majority (119) of those CDWs who had access to internet indicated that the quality of internet connection was workable (Table 8). Moreover, the majority (164) of CDWs who had access to the internet indicated that they accessed the internet more than once per day, but 7 CDWs had no access to the internet (Table 9).

Table 7: Types of computer devices accessible to CDWs

Device type	Response
Desktop computer	52
Tablet	24
Laptop	312
Smartphone	244
Others	17

Table 8: Quality of internet connection as experienced by CDWs

Quality of internet connection	Response
Very fast	10
Fast	31
Workable	119
Slow	67
Very slow	43
Very reliable (never drops connection)	2
Mostly reliable	0
Does drop connection sometimes	15
Regularly drops connection	2

Table 9: Frequency of access to the internet by CDWs

Frequency of internet access	Response
More than once per day	164
Once per day	61
Once per week	47
Once per month	10
Never	7

Testing for Validity

The test for validity of the pretest and the posttest response data was performed using reliability and convergent validity estimations. The convergent validity shows the extent to which items represent the same measurement and is measured using the standardized item loadings that should fulfil the 0.4 requirements (Kawashima & Shiomi, 2007). The reliabilities of the response data were found to be 0.95 for the pretest data (N=327) and 0.95 for the posttest data (N=189) (Table 10). In addition, the data mean scores were found to have improved from 23.53 for the pretest data to 62.17 for the posttest data, meaning that CDWs generally responded well after the training intervention. This improvement in the mean of response data is significant and it could be said that the e-skills training intervention had impacted significantly on the CDWs.

Table 10: Descriptive statistics of pretest and posttest measures

Statistics of Pretest and Posttest Data	Pretest	Posttest
Mean	23.53	62.17
Standard deviation	22.84	25.39
Skewness	1.16	-0.66
Kurtosis	0.74	-0.32
Inter quarter range	29.83	33.33
P-25	5.26	47.37
Median	15.79	66.67
P-75	35.09	80.69
Reliability	0.95	0.95

Table 11 shows the mean, standard deviation and item loadings for each e-skills domain measured. The mean scores for the pretest data vary from the lowest (1.31) for item Q37 to the highest (2.34) for item Q39, meaning the CDWs generally responded below the average score of 3. This result is a reflection of the general low e-skills levels of CDWs, hence confirming the statement of coordinators that CDWs were generally at low e-Skills levels. In Table 11, the mean scores for the posttest data can be seen to vary from the lowest value of 3.12 (Q34) to the highest value of 3.63 (Q33). This result means that CDWs generally responded to each e-skills domain above the average score of 3. The item loadings are the same for both the pretest and the posttest data. These values vary from the lowest value of 0.42 to the highest value of 0.63, which fulfills the 0.40 requirements. This, therefore, provides an empirical evidence of acceptable convergence validity. Moreover, the reliabilities of data were found to be very high, which enabled us to further proceed with the analysis of the response data.

Table 11: Mean, standard deviation and factor loadings for items

	Pretest			Posttest		
Code	Mean	Standard deviation	Loadings	Mean	Standard deviation	Loadings
Q25	1.98	1.00	0.63	3.45	1.16	0.63
Q26	2.30	1.05	0.54	3.60	1.12	0.54
Q27	1.70	1.01	0.58	3.42	1.21	0.58
Q28	1.57	0.88	0.53	3.30	1.17	0.53
Q29	1.88	1.10	0.53	3.34	1.21	0.53
Q30	1.60	0.92	0.51	3.28	1.35	0.51
Q31	1.43	0.79	0.45	3.21	1.25	0.45
Q32	1.77	0.96	0.52	3.25	1.21	0.52
Q33	2.04	1.10	0.54	3.63	1.06	0.54
Q34	1.43	0.81	0.45	3.12	1.47	0.45
Q35	2.00	1.14	0.62	3.52	1.12	0.62
Q36	1.59	0.89	0.50	3.40	1.17	0.50
Q37	1.31	0.66	0.42	3.21	1.30	0.42
Q38	1.54	0.84	0.50	3.21	1.15	0.50
Q39	2.34	1.14	0.53	3.74	1.07	0.53

	Pretest			Posttest		
Code	Mean	Standard deviation	Loadings	Mean	Standard deviation	Loadings
Q40	1.54	0.90	0.48	3.17	1.23	0.48
Q41	1.56	0.91	0.46	3.40	1.22	0.46
Q42	1.51	0.83	0.46	3.43	1.27	0.46
Q43	1.53	0.88	0.58	3.30	1.23	0.58

Comparing e-Skills Levels

The complementary application of CTT and IRT provided a robust analysis of e-skills levels of CDWs. Based on the estimated CTT and IRT parameters given in Table 12, we can see some improvement in the e-skills levels of CDWs. The pretest responses showed that only 16% (p-value=0.16) of CDWs responded well to item Q39 (I have the skills to facilitate mobile interaction between community members and government representatives using social media such as SMS, email and Twitter), while 2% (p-value=0.02) responded well to item Q37 (I have the skills to set up a financial budget using an electronic spreadsheet). The discriminations are very high for item Q39 (a=1.09) and item Q37 (a=1.97) respectively. The difficulties of the items are also very high Q39 (b=1.35) and Q37 (b=2.66). In fact, it can be seen generally that all items have very high discriminations ranging from 1.14 (Q29) to 1.97 (Q37), very high difficulty ranging from 1.39 (Q26) to 2.66 (Q37) and no pseudo-guessing as c=0 for all items. The direct implication of this result is that the majority of CDWs could not effectively use ICT to perform tasks in the workplace. These tasks, include, for instance, setting up a financial budget and facilitating mobile interaction between community members and government representatives. Moreover, there was a clear differential between the e-skills of those CDWs who were able to use ICT and those who were not. The posttest responses indicated that the e-skills training had generated significant impact on CDWs because their e-skills levels had improved significantly. The percentage of CDWs who responded to each item had increased after the training. The p-value, for instance, had risen from the range of [2%, 16%] to the range of [21%, 51%], which can be considered significant. In addition, the discrimination level had fallen from the interval of [1.14, 1.97] to [0.77, 1.18] and the item difficulty had decreased from [1.39, 2.66] to [-0.03, 1.38]. This result further indicated some improvement in the e-skills levels of CDWs as a result of the pilot training implemented in this research case study.

Table 12: CTT and mIRT parameters that gave the best estimate of e-skills levels of CDWs

	Pretest						Posttest						
Code	Discr	PVal	PBis	a	b	c	Code	Discr	PVal	PBis	a	b	c
Q25	0.27	0.08	0.59	1.77	1.68	0	Q25	0.52	0.47	0.46	0.77	0.14	0
Q26	0.37	0.15	0.52	1.15	1.39	0	Q26	0.69	0.51	0.55	0.92	-0.03	0
Q27*	0.32	0.09	0.55	1.48	1.63	0	Q27*	0.68	0.41	0.52	0.95	0.31	0
Q28	0.12	0.03	0.47	1.89	2.23	0	Q28*	0.60	0.34	0.49	0.91	0.62	0
Q29*	0.35	0.12	0.51	1.14	1.60	0	Q29*	0.62	0.33	0.49	0.99	0.61	0
Q30	0.21	0.06	0.46	1.37	2.02	0	Q30*	0.62	0.35	0.48	0.96	0.55	0
Q31	0.13	0.04	0.41	1.40	2.31	0	Q31*	0.71	0.32	0.53	1.18	0.60	0
Q32	0.23	0.07	0.48	1.27	1.91	0	Q32*	0.69	0.38	0.49	0.87	0.46	0
Q33	0.32	0.10	0.53	1.25	1.65	0	Q33*	0.79	0.50	0.63	1.16	0.00	0
Q34	0.11	0.03	0.39	1.58	2.35	0	Q34	0.38	0.21	0.38	0.71	1.38	0
Q35	0.38	0.11	0.60	1.48	1.52	0	Q35	0.65	0.46	0.51	0.76	0.17	0

	Pretest						Posttest						
Code	Discr	PVal	PBis	a	b	c	Code	Discr	PVal	PBis	a	b	c
Q36	0.14	0.04	0.46	1.59	2.15	0	Q36	0.58	0.45	0.46	0.76	0.21	0
Q37	0.05	0.02	0.36	1.97	2.66	0	Q37*	0.58	0.30	0.46	0.84	0.81	0
Q38	0.11	0.04	0.45	1.64	2.23	0	Q38*	0.61	0.33	0.48	0.90	0.65	0
Q39*	0.43	0.16	0.53	1.09	1.35	0	Q39*	0.79	0.47	0.58	0.93	0.12	0
Q40	0.16	0.06	0.43	1.29	2.11	0	Q40*	0.61	0.28	0.49	1.04	0.80	0
Q41	0.12	0.04	0.42	1.47	2.28	0	Q41	0.67	0.42	0.53	0.95	0.30	0
Q42	0.11	0.03	0.41	1.66	2.33	0	Q42*	0.75	0.36	0.56	1.10	0.47	0
Q43	0.20	0.06	0.53	1.77	1.94	0	Q43*	0.67	0.34	0.48	0.79	0.67	0

The asterisk (*) indicates the useful items with significant improvement after the post intervention

The true e-skills levels of CDWs were estimated using a maximum likelihood algorithm (Equation 1 and Equation 2). The estimated e-Skills levels were placed on a 7-point Likert scale for easy interpretation and to easily determine the effectiveness of the pilot training. The result in Figure 4 indicated a significant improvement in the e-skills levels as the posttest curve is seen to increase above the pretest curve towards the upper edge of the e-skills scale. In particular, about 82% of CDWs were moderately skillful, while about 11% of them were somewhat skillful before the pilot training execution, which was generally unsatisfactory. This e-skills deficiency had significantly improved because about 18% of CDWs were somewhat skillful, 13% of them were very skillful and 20% of them were extremely skillful after the pilot training. The pilot training yielded an overall improvement rate of about 33%. However, it is interesting to discover that a certain group of CDWs (about 22% of them) was found to be extremely unskillful after the pilot training. The CDWs in this group needed a special attention as they were confused after the pilot training execution. They initially considered their e-skills levels to be moderate, but perceiving the nature of the training intervention, their self-efficacy considerably dropped and they became more confused. This kind of problem as observed in research case study, is generally referred to as response shift biased that was earlier mentioned. The CDWs may have changed their minds about the pretest scores in the post testing when they perceived the pilot training to be tougher for them. In a particular scenario, for instance, one training facilitator reported that certain CDWs were required to perform a simple financial analysis using the Microsoft Excel, but surprisingly, after they had entered the required financial data into the Excel, they used their calculators to calculate, instead of using Excel formulas. In this particular scenario, knowing that calculators should not be used complementary with a computer to perform a numerical computation reduced the self-efficacy of these CDWs.

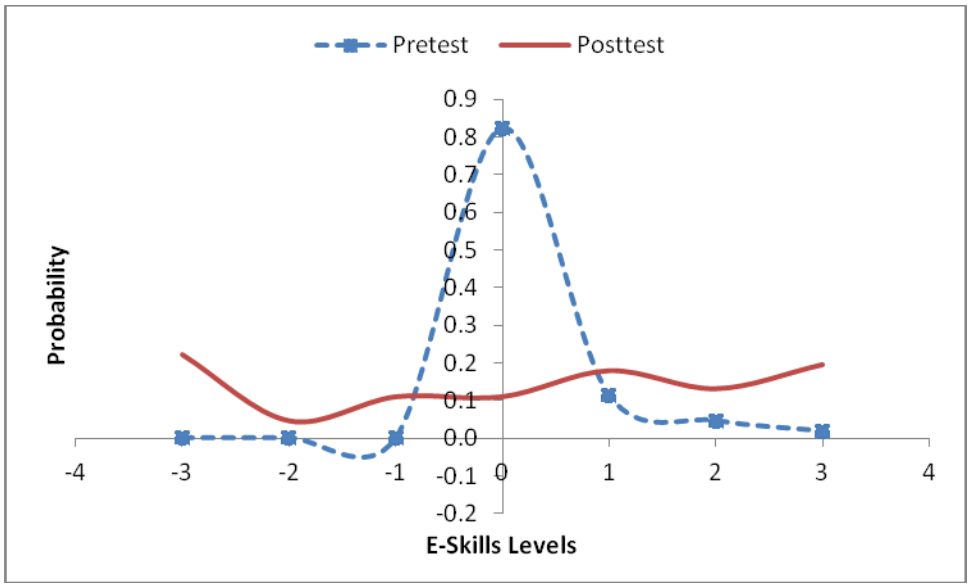

Figure 4: The effectiveness of a pilot training intervention by comparing e-Skills levels

Conclusion

The research case study here reported is a particular scenario of empowering CDWs in the KZN province of South Africa to enhance their delivery of community development services using ICT. The e-SI, COGTA and South African Local Government Association (SALGA) through a multi-stakeholder collaboration decided to address the e-skills deficiency among CDWs towards their empowerment. The first high priority consideration of these stakeholders was to develop the e-skills levels of CDWs to achieve the goal of empowerment. The KZN e-skills Co-lab was, therefore, tasked with the responsibility of implementing a pilot e-skills development training and to research on the effectiveness of the training. The critical task, therefore, for the Co-lab was to design, implement and evaluate a pilot training for CDWs as well as to recommend possible interventions towards a policy change.

The researchers at the Co-lab spent nearly seven months researching and collecting pertinent information as evidence to support the success or failure of the e-skills training. The researchers had a series of strategic planning meetings with the representatives of e-SI, COGTA and SALGA who were directly responsible for the affairs of CDWs. A preliminary research work was conducted, stakeholders were consulted and their recommendations were extensively studied. The general findings of this particular research case study and recommended decisions are summarized in this concluding section.

Findings

The general findings of this research case study can be summarized on the basis of the research questions that were examined during the research case study:

a) The CDWs mainly write reports and attend stakeholder meetings, which they do about 50% or more of their time (Table 5 and Table 6). If the CDWs mainly write reports about community development activities and projects as well as attend stakeholder meetings to provide feedbacks to the appropriate authorities about progress within their communities, then certainly they required more than the basic e-skills to be effective. They certainly required a more specialized software tool to aid them to efficiently keep adequate records, rapidly generate reports with less stress, support community activities as wells as projects monitoring and evaluation. The CDWs cannot obviously perform

these complex activities using the basic e-skills to engage the application of ICT for improving effectiveness.

b) The studio training method with the aid of a Blackboard software helped us to practically improve the e-skills levels of CDWs. Since the goal of the e-Skills training was to shift the pretest normal curve around the moderate e-skills scale to the upper edge of the e-skills scale, the pilot training yielded a significant result, although further improvement is required (Figure 4). The majority of the CDWs (about 52%) improved in their e-skills levels after the pilot training implementation. The improvement result is impressive, however, some CDWs were found to have their e-skills levels extremely unsatisfactory. This group of CDWs was identified after the pilot training to need further attention.

c) The findings of this research case study have assisted us in arriving at a set of possible interventions for improving the effectiveness of community service delivery using ICT. These interventions are comprehensively discussed in the subsequent decision subsection.

Decision

The understanding of the nature of tasks performed by CDWs using ICT and the measurement of e-skills levels of CDWs have better positioned us to recommend some interventions. The decision that was followed to arrive at the recommended interventions was based on the following important criteria:

a) Feasibility – is the extent to which the intervention is economically viable to implement in order to solve the unique community service challenges.
b) Acceptability – is the extent to which politically or socially, the intervention is equitable, ethical, constitutional and the communities will be willing to accept the intervention as solving their unique community service challenges.
c) Effectiveness – is the likelihood that the intervention will accomplish the intended purpose of solving the unique community service challenges.
d) Sustainability – is the extent to which the intervention is sustainable in solving the unique community service challenges in the case that an unexpected event occurs. This is for instance, includes unavailability or insufficiency of resources to continuously fund the intervention.

The critical finding of this research case study is that a studio training intervention with the aid of ICT yielded a significant improvement in e-skills levels of CDWs. However, there are a number of factors that can inhibit the successful applications of ICT by CDWs, amongst which are the following:

a) The educational background of CDWs might limit them to rapidly grasp some of the important strategies that could help them build sufficient skills in the use of ICT.
b) The training duration might be too short for CDWs to master the rudimentary concepts that could help them to adequately apply ICT in the workplace.
c) The training costs might be too high to sustain the possibility of constantly training CDWs on the latest technology that they could use to improve their service delivery effectiveness.

The grounding of e-skills development in a program that expands the boundaries of knowledge beyond the basic ICT literacy will be instrumental to the success of CDWs. Intuitively, by ruminating on sustainability and costs of constant training, evolving and dynamic nature of ICT as well as other risk factors, we therefore, recommend the creation of a specialized community service delivery system to improve the effectiveness of public service delivery to communities. The three possible interventions to be considered in an open discussion are the following.

a) Provide more frequent e-skills development training for community development workers to continuously improve their service delivery effectiveness.
b) Advocate for e-skills as a basis prerequisite for community development workers to seek employment in the public service.
c) Create a specialized innovative community service system to be used by community development workers to facilitate effective delivery of public services to their communities.

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Biographies

Oludayo, O. Olugbara is with the Department of Information Technology, Durban University of Technology (DUT) in South Africa. He is a member of the Association for Computing Machinery (ACM) and the Computer Society of South Africa (CSSA). He is the Vice Chair of Space Science Research Group and Lead, Mobile and Wearable Computing in Emerging Service Economy (MOWECSE), Research Group at DUT. He coordinates the e-Skills research activities of the KZN Co-Lab at DUT. His research inclinations include Machine Learning, Computer Games, Image Processing, Grid/Cloud computing, e-Healthcare, e-Commerce, e-Government and Smart City Technologies.

Richard Millham is an academic in the Faculty of Accounting and Informatics in the Department of IT at Durban University of Technology. His research interests are in software and data evolution, big data, service oriented computing, and IT education (including e-learning)

Delene Heukelman has been a researcher for 14 years and has published a number of papers. Her main area of interest is User Interfaces and making them more accessible to users in general, but also specifically to non-English speakers and rural communities. As curriculum director of the eSkills Institute KZN CoLab she contribute towards the development of a national curriculum and competency framework for the eSkills Institute. As a senior staff member of the Department of Information Technology at the Durban University of Technology she plays a role in deciding the direction of the department and contributing towards improving all aspects of the department. She is passionate about promoting ICT within society to ensure that all South Africans can participate in the Knowledge Society with confidence.

Colin (Surendra) Thakur is Director at the KZN e-Skills CoLab which is tasked with e-skills education in general, and particularly on the e-enablement of government services for effective service delivery. He conceptualized and introduced InvoTech, an innovation incubator at DUT. Colin Thakur was the Chairman, Vice-Chair and National Treasurer for the years in worked with the KZN Computer Society of South Africa. He served on the Inaugural Complaints and Compliance Committee (CCC) of ICASA. Colin was commissioned by the IEC to undertake an international study of electronic voting (e-voting) practices completed in 2012 called "Electronic Voting – the cross-national experience." Colin delivered 6 key notes on this topic, wrote five papers and was an international observer in the Zambian election. He will observe two e-voting elections

Harold Wesso (Biography and photo not available)

Mymoena Sharif is the Chief Director of the Department of Communications iKamva National e-Skills Institute, a South African government initiative to advance and implement key e-skills interventions. She is a member of the Strategic Council for the United Nations Global Alliance on ICT for Development and is a former winner of the Bill & Melinda Gates International Access to Learning Award. She is co-author of the South African National e-Skills Plans of Action (NeSPA 2010 and NeSPA 2013).