Developing a Multi-stage Assessment Framework to Measure E-skills Level of Community Development Workers in South Africa

By

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DECLARATION

I, Ridwan Opeyemi Fasasi declare that this dissertation is a representation of my own work both in conception and execution. This work has not been submitted in any form for another degree at any university or institution of higher learning. All information cited from published or unpublished works have been acknowledged.

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DEDICATION

This work is dedicated to Almighty Allah and Rasulullah (SAW).

I have learnt to accept that there are my plans and also Allah's plans for me. My plans are according to my wishes and His plans are according to His infinite wisdom. I need to trust Allah with all my heart and always remember that He knows what is best for me.

Always.

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“A winner is a dreamer who never gives up”

Nelson Mandela

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Community Development service practitioners in South Africa have been increasingly burdened with a broader range of responsibilities. Using ICT proficiently could enhance their productivity. The use of ICT is prevalent in almost every organization, therefore, it can also serve as a major factor in providing flexibility of service to communities, but only if the practitioners possess adequate skills in retrieving, presenting and disseminating valuable and adequate information within the workplace to the parties involved. Training interventions are however not always successful and their impact need to be measured.

This study focussed on developing a Multi-Stage assessment model to measure the impact of an ICT training intervention, to provide evidence of the effectivity of the training. A syllabus was developed, based on the European e-Competence Framework for ICT Users - Part 1 (CEN, 2013) and contextualized to suit the work environment of Community Development Workers (CDWs) from KwaZulu-Natal, training material was created and a Learning Management System was used to deliver the training. A self-assessment questionnaire was used to determine the pre-training skills level of the CDWs, 189 CDWs from KwaZulu-Natal were trained and a second questionnaire was used to measure the impact of the training.

Results were analysed using Item Response Theory, which provided a way to measure not only overall competency but responses to specific items. Classical Test Theory measuring frequencies and averages were also use and the two sets of responses were compared. The training was found to be effective. Recommendations towards the development of a Multi-Stage assessment model are made.

CHAPTER ONE

1.1. INTRODUCTION

The Community Development Worker (CDW) program is a holistic approach to enable communities and the government to work together in South Africa. It was established by the government in 2003 (Davids and Cloete, 2012) with the aim of addressing poverty and bridging the gap between the government and citizens. This program also aimed to address under-spending of annual budgets by local government and unproductive service delivery (Geber and Motlhake, 2008). The CDWs serve as intermediaries between the government and communities and are deployed in every municipal ward in the country. Furthermore, they are expected to inform the poor of their constitutional right to access and claim basic services from the government. They also educate less privileged community members on how to participate in local development plans and help them access social grants (Mashaba, 2011; Raga *et al.*, 2012).

According to the Handbook for Community Development Workers (2006), Community Development Workers work with and assist communities by collaborating with all government departments who are responsible for the implementation of projects and programmes at local level. These programs include, among others, poverty alleviation programs, provincial and local government programs (Local Economic Development (LED) programs, Municipality Infrastructural Grant (MIG), Free Basic Service (FBS), Integrated Sustainable Rural Development Program (ISRDP) and Urban Renewal Development Program (URDP), agricultural and land reform, housing, primary health care, water and sanitation and Small Micro and Medium Enterprises (SMME) support programs.

CDWs are expected to disseminate government and other information to community members in a timely and equitable manner and channel feedback from the community to service providers. They are also required to facilitate the coordination of programs to develop the community. In short, “CDWs will act as resourceful, dedicated cadres at local level by improving accountability to, and contact with communities at all levels of government at certain intervals in order to develop and sustain partnership with civil society” (Handbook for Community Development Workers, 2006).

1.1.1. Selection of Community Development Workers

The Handbook for Community Development Workers (2006) states that one of the selection criteria is that the applicant must "have attained a minimum of NQF level 4 or grade 11 (standard nine) or equivalent to access the learnership" (Handbook for Community Development Workers, 2006). CDWs therefore have a reasonable grasp of English, which is important, as all their reporting takes place in this language. They also have to be able to interact with line managers as well as the community that they serve.

1.1.2. Primary functions of CDWs

The majority of communities in South Africa, especially those in rural and disadvantaged areas, do not have adequate access to public services. Government is thus tasked with extending these services to ordinary citizens. Community development workers act as mediators between the government and communities in an effort to holistically deliver improved public services, irrespective of geographical location. The CDWs are community members who are mandated by the government to perform different functions within their communities. Many of these functions can be supported by information and communications technology (ICT) applications to improve efficiency. According to the 2006 handbook for CDWs (Handbook for Community Development Workers, 2006), their functions include the following:

i. Developing strategies to encourage community participation and raise awareness of available government services and programs within communities.

ii. Alerting community members and appropriate service providers to the critical challenges associated with delays in providing basic services to communities.

iii. Disseminating government information to communities in a timely and equitable manner and in an accessible form.

iv. Receiving feedback from communities and directing it to the appropriate service providers.

v. Assisting communities in the effective implementation of government programs and projects.

vi. Monitoring and evaluating the impact of developmental programs on communities and submitting reports to relevant government structures. (Handbook for Community Development Workers, 2006)

1.1.3. Training of Community Development Workers

The basic education and training of CDWs involves a learnership; “most of the CDWs would go through a learnership process of one year. During this period there will be some theoretical work, although most of the emphasis will be on community-based learning and practical experience” (Handbook for Community Development Workers, 2006). The first intake of 1,300 CDWs “completed a one-year training programme – combining class-based and in-service training – at institutions such as the University of the Western Cape. A further 900 community development workers were recruited in November” (South Africa's Community, 2005: On-Line).

The National e-Skills Plan of Action for South Africa (2013) has initiated a process to move South Africa towards a knowledge-based economy. “The WEF global e-readiness report identifies lack of appropriate skills as a major contributor” to South Africa being ranked much lower in 2012 than in 2007 (NeSPA, 2013). Greater efforts are therefore required. “The deliberations in developing the South African National Development Plan – Vision 2030 inter alia identified coordination within government, the private sector, education and civil society along with people centred development” (NeSPA, 2013) as key to achieving this goal.

E-literacy includes the ability to use a cell phone, the Internet and computers to access information and interact effectively and efficiently within the social, learning and workplace space.

E-literacy can also be grouped as shown in Figure 1.1, in terms of using these technologies to retrieve, generate, and disseminate information. Improved e-literacy thus refers to gaining the skills to use digital technologies to perform specific functions/tasks to retrieve and organize

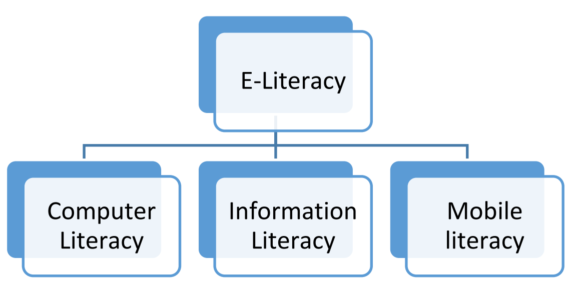

Figure 1.1: Components of e-Literacy

information for communication (Buckingham, 2006). This involves computer software packages, such as spreadsheets, word processors, RSS feeds, presentation packages and any format relating to documentation, including file management, as well as smartphone technology and social media. It could be argued that at a higher level, the ability to access databases and use search engines is also categorized as e-literacy, while access to information and understanding it, fall under information literacy.

1.2. Problem Statement

All CDWs in KwaZulu-Natal (KZN), where the research took place, were equipped by the provincial government with a laptop, data bundles and smartphones, but the national and provincial government raised concerns over the efficient and effective use of this technology by CDWs. Although some e-literacy skills are gained informally by using technology in everyday life, the national, provincial and local stakeholders identified the need for focused training to improve the level of skills to enhance productivity.

A training program was therefore suggested that would focus not only on computer literacy, but on the broader context of e-literacy in general. The content of the training program was closely matched with the e-skills required within the CDWs work environment in order to improve productivity. This was achieved by analysing the work done by CDWs on a daily basis and identifying areas where ICT could play a role. A self-reporting questionnaire not only indicated the CDWs' existing e-skills levels, but the general extent of use of ICT in their work environment.

Training interventions take place in many different sectors on a regular basis, but often the impact of these interventions are questioned. The research problem identified was how to measure the impact of the training in this particular instance and identify possible strategies for further training.

1.3. Study Motivation

The Department of Communication (DoC) is the government agency mandated by the South African government to drive the "national agenda of e-skilling the nation" through its e-skills Institute (e-SI). The Ikamva National E-skills Institute (INeSI) was introduced to the public on 21 February, 2014 at the Durban University of Technology (DUT).

Based on the need to promote an information society to enhance development, the e-skilling of the South African population was recommended by the Presidential International Advisory Council (PIAC) in 2007. "The e-SI has adopted a multi-stakeholder collaborative approach by engaging government, business, civil society and organized labour to respond rapidly to the e-skills challenge in South Africa. The deliberations to develop the South African National Development Plan (SA-NDP) vision 2030 identified coordination within government, the private sector, education and civil society, along with people-centric development, as key to achieving a knowledge-based economy and information society" (Olugbara et al., 2014).

The e-SI aims to grow the country's human resources by means of holistic e-skills interventions and to successfully embed ICT in the lives of South Africans. The e-SI initiated the NeSPA in 2013 to help move the country towards "a knowledge-based economy and information society. Its philosophy revolves around people-centric development as articulated in the SA-NDP vision 2030" in order to build the capabilities (see NDP pillar 4) required for increased self-reliance. The e-SI's primary goal is to "build astute citizens in order to develop an inclusive economy in a developmental state that is increasingly dominated by modern ICT capacities. The concept of e-astuteness refers to the capability to use ICT for personal development and self-reliance". According to Taylor et al. (2013), "e-astuteness" is not confined to those that are formally educated, but includes the full spectrum of society and "would allow individuals and collectives to exploit" the many advantages of ICT.

In order to e-skill the nation a number of training interventions were launched. Funding for training interventions require demonstrable measurement of impact. Various ways may be used to measure impact, but there is a distinct lack of measurements which provide a quantifiable measure of the impact of training, especially in e-skills where individuals often acquire a range of skills informally from using technology every day.

1.4. Aims of the Study

This study aimed to develop a Multi-stage Assessment Framework to measure CDWs' e-skills and to monitor the implementation and impact of training. It examined how ICT could enhance service delivery by CDWs and how ICT training could improve their e-skills.

The objectives of the study were to:

- Identify which ICT skills could enhance CDW's productivity.
- Identify what the current skills level of the CDW's are in these skills.
- Identify possible measurement strategies to yield a quantifiable impact measurement.

The key research questions that emerged at the early stages of the evaluation were as follows:

- Which ICT skills are CDWs required to use in their work environment to meet their Key Performance Indicators (KPIs)?
- Which (ICT) skills require improvement to enhance CDWs' productivity?
- How can the impact of the training be measured in terms of upgrading the ICT skills to improved KPI's for CDWs?

1.5. Summary of Methodology Employed

The first step was to determine which ICT tools could enhance CDWs' productivity. A self-reporting questionnaire was used to identify the routine tasks undertaken by CDWs. The questionnaire also gathered information on environmental conditions and the current use of ICT.

The second step was to identify the CDWs' existing e-skills levels. The e-skills evaluation framework for community development provides a means of describing ICT users' skills using the European e-Competence Framework for ICT Users - Part 1 (CEN, 2013) as a basis, but adapting it to the specific KPIs of the CDWs. The same self-reporting questionnaire was used to enable participants to assess their own skills levels within the adapted European e-Competence Framework.

Training was introduced to a group of 187 participants and the self-reporting questionnaire was administered again to measure the impact of the training. Classical Test Theory (CTT) and Item Response Theory (IRT) were used to analyse the data and identify trends.

1.6. Study Outline

Following this introductory chapter, Chapter 2 reviews the literature that is relevant to the main aim of the study and is useful in informing it. It begins by examining the concept of measuring value-added in learning and value-added modelling of learning. The chapter highlights that the selection of a value-added model is guided by the advantages and disadvantages of the various models proposed in the literature.

The concept of value-added measurement are discussed and the relevance approaches of measuring acquired skill in education programs are investigated. Key issues relating to value-added measurement and formative assessment systems in education are discussed, including the Pre-Test and Post-Test methods. Different initiatives to improve the assessment of learning in education are explored, including assessment effectiveness, improving educational institutions and quality assurance with a focus on improved outcomes. The focus of the literature review then narrows to specifically explore the theory and practice of self-assessment, measurement inspection and planning (O'Brien Maguire, 2011).

Chapter 3 presents the theoretical framework for this study which was supported by Rogosa (1995). The theory posits that the two most important learner outcome measures are persistence (students should complete their program's learning) and that students should gain knowledge, skills or abilities from these programs. The theory demonstrates that additional rounds of Pre- and Post-Testing can dramatically improve the performance and reliability of the education training program and outcomes.

Chapter 4 details the methodological approach adopted by the study. Quantitative, qualitative, approaches were considered before choosing selecting a mixed methods approach. This chapter also motivates why this approach was followed.

Chapter 5 presents and discusses the research findings. The outcomes of both Pre-assessment and Post-assessment are presented and the research questions are answered. The research questions focused on the alternative methods of analysis to determine the effectiveness of the training intervention, including the impact on the skills levels of the CDWs.

Finally, Chapter 6 presents the study's conclusions and recommendations. It follows numerous stages in the study process and highlights the key findings of the study. The research questions are summarized and final conclusion is present based on the finding. Following the recommendations, a multi-stage assessment framework is recommended as a national learning improvement strategy and the need for further research is presented.

1.7. Publications

This work has resulted in the development of a Multi-stage Assessment Framework and the following research publications are published or submitted to peer-reviewed journals.

1. Fasasi, R. and Heukelman, D. 2014. Development and Validation of a Longitudinal Assessment Model using Normalised Change to Improve the Quality of Educational Outcome Standards. *Mediterranean Journal of Social Sciences.* (Accepted)
2. Fasasi, R. and Heukelman, D. 2016. ICT: Performance Evaluation of Community Development Worker's in South Africa on E-skills. *Journal of Information Technology for Development.* (Submitted)

CHAPTER TWO

LITERATURE REVIEW

This chapter presents the findings of an extensive literature review to determine existing research on measurement of education in general. Item Response Theory and Classical Test Theory are introduced as appropriate tools to analyse the responses to tests to quantify the impact of education and training.

2.1. Introduction

Since there are many tiers and layers of human beings' social and biological development, scientific and environmental issues should be taken into account in measuring the value-added of students' learning and acquired skills. This renders the assessment of education a complex task. This chapter reviews the literature on value-added measurement approaches, methodologies, and challenges within education contexts. It examines the properties of the value-added assessment system and their application as well as how the statistical models such as CTT and IRT can be applied and technical issues relating to their modelling processes. The literature review also sets out the key theories and approaches that informed this study. Many of the philosophies that underpinned the study overlap in some areas of analysis. The criteria for selecting an appropriate model are reviewed in order to provide recommendations for future development.

2.2. Value-Added Measurement

Value-added assessment is a method that is used to quantify the amount of knowledge that a student has gained from a particular academic program as well as to measure instruction and learning. This is based on the student's ability prior to the training. This method enabled the researcher to determine the extent of the students' development over a period of time in a particular leaning area. Value-added assessment enables an assessment of whether or not a particular student has gained/acquired additional knowledge from the training program, for example, e-skills training. Thus, the 'long-term' influence of a particular teacher or school on student achievement can be identified (Rowan *et al*., 2002,). Value-added assessment has gained popularity in a number of countries as a method to measure the effectiveness of teaching and learning; it allows both researchers and education officials to determine the progress made by individual students as well as the extent to which individual teachers, schools, and districts have contributed to that progress (Braun, 2005; Harris & McCaffrey, 2010).

In recent times, there has been a shift in educational policy to link teacher remuneration and tenure to student performance in addition to traditional measures such as certification and qualifications. Many countries are currently adopting this system. For example, in the US, Tennessee, North Carolina, Florida, Pennsylvania, and Ohio as well as cities such as Minneapolis, Dallas, Houston, Denver, and Washington DC use a multi-stage assessment system to evaluate teachers and/or schools in order to enhance the quality of education and improve graduation rates (Downes & Vindurampulle, 2007).

The Texas government has invested heavily in the Educator Excellence Award Program (GEEAP) that rewards teachers on the basis of performance evaluation (Koedel & Betts, 2009). Different countries have developed programs to evaluate academic training institutions' (and thus teachers') performance by measuring learners' achievements, such as the average score in standardized tests or the percentage of learners progressing to the next academic level (OECD, 2008). The Teacher Advancement Program (2012) emphasizes that learners' achievements are a measure of development.

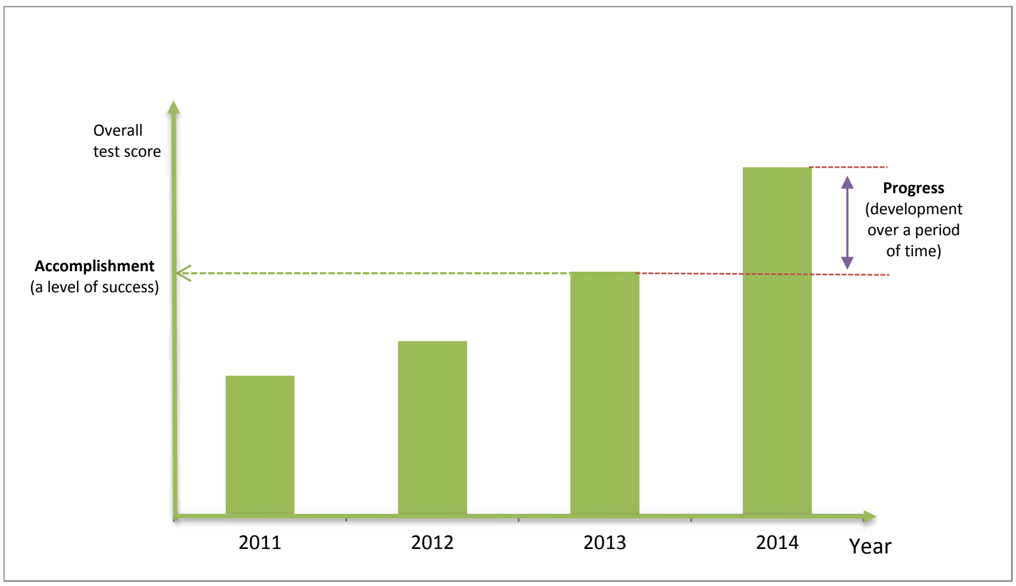

Figure 2.1: Two different ways to measure student teaching and learning achievement

The level of accomplishment learners acquired at a certain point in time (Figure 2.1) is referred to as attainment which means the level at a particular time, e.g., the score for a standardized test at the end of each semester. Academic attainment is normally measured in terms of output as a numeric score or the achievement of a standard grade; this is used to evaluate an institution's performance. In contrast, development relates to the progress that learners achieve over a long period of time as their education proceeds (Harvey, 2004).

According to Doran and Lockwood (2006), value-added modelling is a statistical model that is used to gather data on learner achievement over a certain period of time in order to measure their learning gains. Value-added models can be used to answer research questions such as:

i. "What is the amount of observed variance in student achievement that can be attributed to a school or teacher?"
ii. "Is an individual school or teacher effective in producing gains?"
iii. "Which features or institutional practices are associated with effective schools?"

In line with the earlier description of the value-added measurement system, the statistical approach adopted for value-added measurement in a number of countries to assess the performance of teachers or schools is not appropriate. This is due to the fact that, in many cases, changes in learner achievement over a period of time are not prioritized; rather, the focus is on overall changes in a student's achievement relating to a particular academic program, with the aim of ensuring that students complete their schooling (Robinson *et al*., 2008; Chudowsky *et al*., 2010).

In some countries, learner achievement is measured by comparing the results of a test for a particular subject over a period of time; an example is Adequate Yearly Progress in the US (Doran & Izumi, 2004). In this cohort-to-cohort change model, value-added measurement is not considered, as the change in a learner's knowledge/skills gained from a previous grade to the subsequent grade is not measured. This type of model focuses solely on changes in mean test scores for a specific grade over time, and does not reflect learner educational growth resulting from training over time.

Statistical or econometric methods are used to calculate future performance, based on students' prior test scores. Teacher effectiveness is measured by the degree to which students have attained, exceeded, or failed to attain a predicted score relative to a typical teacher (Braun, 2005; Harris & McCaffrey, 2010). The most important aspect of value-added methods is to estimate "proportions of variance in changes in student achievement" when the level of student knowledge prior to the influence of the school or a teacher's instruction has been identified (Rowan *et al*., 2002). “Good teachers are ones who get large gains in student achievement for their classes” (Hanushek, 2002).

2.2.1. Advantages of Value-Added Measurement

Value-added measurement provides additional indicators of institutional performance beyond learners' attainment levels for a period of time; it is for this reason that it is used in many countries (Glazerman & Seifullah 2012). The advantages of value-added measurement are:

i. Measuring value-added enables an assessment of the contribution that an academic institution makes to a learner’s academic progress as it monitors a particular student over a period of time by taking their level of knowledge from the start of their academic training into consideration (Doran & Izumi, 2004).

ii. Value-added assessment focuses on changes in scores achieved in a given period of time rather than “on the scores collected at a particular point in time” (Ballou *et al*., 2004; Raudenbush, 2004; Sanders, 2006; Amrein-Beardsley, 2008; Anderman *et al*., 2010; Biancarosa *et al*., 2010). Evaluating each institution's contribution to learner achievement by focusing solely on the percentage of students acquiring certain standards or on attainment levels is not useful, as the knowledge and skills of the learners enrolling at an institution differ (Reardon & Raudenbush, 2009).

iii. Measuring value-added will assist in determining the ‘actual’ value of an academic institution’s contribution to students’ educational improvement as it incorporates the discourse characteristics of students or academics (OECD, 2008).

iv. “Although comparisons of raw test scores provide the necessary information, they are poor measures of institutional performance as they do not reflect differences in contextual characteristics such as learners’ socio-economic backgrounds. By evaluating only one score (i.e., attainment in a standardized test at one point in time), it is difficult to determine the extent to which the score was influenced by factors outside the institution as opposed to factors that can be controlled” (OECD, 2008) inside it.

v. Furthermore, value-added measurement estimates the academic establishment’s contribution to learners’ educational progress without considering contributory factors such as family characteristics and socio-economic background over the course of a college training session

(McCaffrey *et al.*, 2004; Raudenbush, 2004; Braun, 2005; Sanders, 2006; Lockwood *et al.*, 2007; Amrein-Beardsley, 2008).

Value-added measurement offers greater accuracy and a fair assessment. However, some difficulties remain in measuring an institution's contribution to learners' achievement. The measurement of value-added can be supported by the results obtained from the regular test to measure the particular effect of an institution. On-going education in an institution results in skills, customs, ethical (or social) values, and accumulated knowledge and affects the feelings, actions and thinking of students. Functions do not indicate the total accumulation of learning that occurs in an institution; standardized tests normally measure certain facts and skills (Bennett, 2001; Harvey & Green, 1993). Furthermore, an institution's contribution to a student's education may not be immediately apparent but might be revealed in later years. This calls for value-added assessment with previous learners. Caution should always be exercised in discussing an institution's value-added score as the education environment is a complex one (OECD, 2008).

2.3. Criteria for Measurement and Models

In an assessment test, the results of the test are typically used to help make a decision. The results have to be interpreted, and it should be proven that the interpretation is valid under the particular circumstances. Therefore, the soundness of the decision made depends on the validity of the test scores (Hogan & Agnello, 2004). It is essential to ensure that the method used actually measures the psychological trait being assessed. Standards for Educational and Psychological Testing regards validity as: "the most fundamental consideration in developing and evaluating tests" (American Psychological Association, 2014). Measuring psychological quality consistently is one of the foundations of the validity and reliability of the test. Reliability is a condition for validity as it measures the consistency of the application of a particular population at a particular time. A reliable test might be valid or invalid, but an unreliable test will never be valid. A method that produces high reliability in a particular test may result in low reliability elsewhere. Reliability is based on the interaction between certain tasks among the particular population of learners assessed. Reliability is the highest range of validity. Unfortunately, measurement methods such as the SLEP test or TOEFL do not show reliability.

The reliability of a test is probably one of the least understood concepts in testing and is clearly important. Obtaining a standard index with which to evaluate validity is one of the objectives of the reliability coefficient of a test. More importantly, in light of the fact that the reliability coefficient enables one to determine the standard error of measurement, this allows practitioners to respond to the question: If I give this test to this student again, what score would s/he achieve? This is a critical issue in high stakes testing. For example, an examinee scores 79. The cut off mark is 80. He or she's life will take two different paths based on your judgment. What level of confidence do you have in your test? Does s/he pass or fail?

2.3.1. Classical Test Theory (CTT)

The main focus of assessment is designing a tool to measure what one wants to know by selecting a suitable item/question in respect of the testing method adopted. The most commonly used theories for an assessment test are the CTT and the IRT. The CTT is an old assessment method that has been used for decades (Demirtaşlı, 2002; Traub, 1997) and is still used for assessment tests (Bechger *et al*., 2003), while the IRT has witnessed exponential growth in recent decades.

Classical Test Theory is based on the concept of measuring a participant's score for a particular test. It tries to compensate for errors in the actual test to obtain a true reflection of the participant's score. "CTT collectively considers a pool of examinees and empirically examines their success rate on an item" (Fan, 1998). Classical Test Theory is based on comparatively weak theoretical assumptions. The statistics can be computed by generic statistical packages (or if necessary by hand) and require no specialist software, which has resulted in its use in several studies (Hambleton, 1991; Culligan, 2011). Classical Test Theory is applied to the survey or test instrument as a whole, rather than to a specific item/question and although item statistics can be generated, "they apply only to that group of students on that collection of items" (Fan, 1998). With CTT it is assumed that any test score (or survey instrument sum) is comprised of a 'true' value, plus randomized error. Another characteristic of CTT is its extension (e.g., generalizability theory).

The difficulty of a (single response selection) question in CTT is "simply the proportion of people who answered the question incorrectly. For multiple mark questions, it is the average mark expressed as a proportion. Given a scale of 0-1, the higher the proportion the greater the difficulty. The discrimination of an item is the (Pearson) correlation between the average item mark and the average total test mark. Being a correlation it can vary from –1 to +1 with higher values indicating (desirable) high discrimination” (Fan, 1998)

In CTT, reliability is a measure of how well the test or survey ‘holds together’. For practical reasons, internal consistency estimates are the easiest to obtain and they indicate the extent to which each item correlates with every other item. This is measured on a scale of 0-1. The greater the number the higher the reliability (Fan, 1998). Classical Test Theory uses the survey or test (not the item) as its basis. Although the statistics generated are often generalized to similar populations completing a similar survey, or taking a similar test; they only really apply to those students taking that test (Fan, 1998). Latent trait models aim to look beyond this at the underlying traits which are producing the test performance. They are measured at item level and provide sample-free measurement.

Despite its widespread use, CTT has limitations that mainly relate to the statistics of each item and the dependent group items (Hambleton & Swaminathan, 1985). Furthermore, in CTT the person statistic of the observed score is normally item independent, while the statistic of difficulty of each item and the discrimination of each item are normally dependent; therefore, difficulties (e.g., test equating, computerized adaptive testing) arise from the theoretical application of some test measurements (Önder, 2007; Demirtaşlı, 2002; Fan, 1998). However, these issues can be addressed by using the IRT which has received increased attention in recent years.

Specialists in assessment test studies have come up with a reasonable solution to problems relating to measurement when applying the CTT, despite its theoretical weakness in terms of the circular dependence of item and person statistics. For example, the CTT framework can apply an empirical approach to achieve test equating (e.g., equipercentile equating) (Engelhard, 1991; Engelhard Jr, 2008; 2013) Similarly, it can apply an empirical approach to measure item-invariant (e.g., Thurston absolute scaling). While issues remain that might not be solved theoretically in the CTT framework, many will be addressed with the help of an ad hoc empirical process and this approach remains useful.

2.3.2. Item Response Theory (IRT)

The IRT framework encompasses different types of models. The relevance of this model relates to the viability of various theoretical assumptions concerning the test items and the character of the test items. Item Response Theory is more grounded than CTT and models the probability distribution of an examinee's achievement at the item. As its name suggests, the primary focus of the IRT is item-level information. In contrast, CTT primarily focuses on test-level information. In terms of the dichotomously scored test items, there are three IRT models, the three-parameter model, two-parameter model and one-parameter model.

The IRT uses a combination of models to minimize the relationship between response items in order to measure a specific concept. This theory uses mathematical expressions to establish the relationship between the levels of each question and a latent trait, with the likelihood of a specific answer for each item. The mathematical expression uses a non-increasing or non-decreasing linear method (Hays, Morales & Reise, 2000). Unlike CTT, every item is treated separately in the methodical approach of the IRT, even though every item is treated alike in order to produce a reliable result that enables measurement. There are various item parameters, and they are assessed directly with logical models rather than with the scope (of difficulty or threshold) or a discrimination index. As shown in Table 2.1, the differences between the various types of item response theory models include their parameter numbers, regardless of whether they are applied dichotomously or polytomously (1-, 2-, or 3-parameter models).

Table 2.1: Common IRT applied to assessment outcome data (Cappelleri et al., 2014)

Models	**Item response format**	**Model characteristics**
One parameter (*Rasch*) logistic	Dichotomous	"Discrimination power equal across all items. Threshold varies across items".
Two parameters (*Rasch*) logistic	Dichotomous	"Discrimination and threshold parameters vary across items".
Graded response	Polytomous	"Ordered response. Discrimination varies across items".
Nominal	Polytomous	"No pre-specified item order. Discrimination varies across items".
Partial credit (*Rasch* model)	Polytomous	"Discrimination and power constrained to be equal across the items".
Rating scale (*Rasch* model)	Polytomous	"Discrimination is equal across items. Item-threshold steps equal across items".
Generalize partial credit	Polytomous	"Variation of partial credit model with discrimination varying across items".

A dichotomous item with a 1 parameter item response theory can be mathematically expressed as:

$$E_i(Z=1|\varphi)=\left[x^{(\varphi-b_i)}\right]/\left[1+x^{(\varphi-b_i)}\right] \qquad 2.1$$

Where $E_i(Z=1|\theta)$ is the likelihood that all examinees will respond with the same ability level θ to item i, whereas b_i is the difficulty level (P-value) parameter. The discrimination of all items is presumed to be equal in a one-parameter IRT model. The parameter of item discrimination will be included in the two-parameter model. The dichotomous item of a two-parameter model will be mathematically expressed as:

$$E_i(Z=1|\varphi)=\left[x^{D_{ai}(\varphi-b_i)}\right]/\left[1+x^{D_{ai}(\varphi-b_i)}\right] \qquad 2.2$$

Where D is the scaling constant (D=1. 7), while b_i represents the discrimination parameter, all other factors remain as in the model in one-parameter. The difference between each examinee's latent trait and the difficulty of each item has a significant influence on the probability of responding to items with higher discrimination rather than the items with less discrimination. Furthermore, an item with a higher discrimination index acquires more information than items with a lower discrimination index.

2.3.3. Model for Graded Response

Samejima (1969) suggested a model for graded response to extend the dichotomous 2-parameter logistic model (2-PL) to the multiple category case. In the model for graded response, responses to item i are unit typified into m_i+1 types, wherever m represents the best possible score on the item i. The set of possible scores on ab item i, is outlined as $(0,1,....m)$. The response categories are unit ordered. Higher category scores represent more of the trait being measured than do lower scores.

Steinberg and Thissen's (1995) study on a taxonomy of IRT models typified the graded response model as a "difference model." In any particular model, an examinee's explicit response will not directly reflect their level of ability. Samejima (1997) outlined a two-stage approach to establish this probability. First, the probability of a responder with a given trait level marking during a given category or higher category is outlined as:

$$E*_{iy}(\varphi) = \frac{\exp\left[D_{ai}(\varphi - b_{iy})\right]}{1+\exp\left[D_{ai}(\varphi - b_{iy})\right]}, \quad \textbf{2.}3$$

Where a_i is the discrimination-parameter for item i; b_{iy} is the category boundary for score x on item i; D is scaling constant (1.7). The type boundary parameter (b_{iy}) is the difficulty parameter related to category score y for item i. It is represented as the difficulty of obtaining this category score or one higher. For item i, there are $m+1$ potential type responses and m type boundaries. In the uniform case of the graded response model, the discrimination parameter is presumed to be equal across all categories among an item. Equation 1 is employed to work out $E*_{iy}(\varphi)$ (category characteristic function) for all type responses apart from 0 or for *m + 1.* $E*_{iy}(\varphi)$. Extreme type scores are outlined as follows:

$$E*_{i0}(\varphi) = 1 \quad 2.4$$

and,

$$E*_{i(m_1+1)}(\varphi) = 0. \quad 2.5$$

Equation 4 defines the likelihood of scoring in type 0 or higher as unity. Equation 5 defines the likelihood of scoring higher than the highest type score as zero. The second step in determining the likelihood that a testee with the given trait level can score in a specific type requires the subtraction of adjacent type characteristic functions. Specifically, the likelihood that an examinee with a given trait level can score in a specific type is outlined as:

$$E_{i_y}(\varphi) = E_{i_y}*(\varphi) - E_{i_{y-1}}*(\varphi). \quad 2.6$$

Samejima (1997) also outlined the item data function for the graded response model with the following equation:

$$T_i(\varphi) = \sum_{y-0}^{m_i} \frac{\left[E'_{iy}(\varphi)\right]^2}{E_{iy}(\varphi)} - \sum_{y-0}^{m_i} E''_{iy}(\varphi), \quad 2.7$$

Where $T_i(\varphi)$ is information for item i, for testee with trait level equal to φ; $E_{iy}(\varphi)$ is the probability of respondents of a given trait level responding in the category y; E'_{iy} is the first derivative of $E_{iy}(\varphi)$; E''_{iy} is the second derivative of $E_{iy}(\varphi)$. The second term in Equation 8 is equal to zero and, therefore, drops out of the equation. The test data function is the same as the sum of the item data functions.

2.3.4. The Partial Credit Model

The partial credit model (PCM) was introduced by Masters in 1982. As is the case with the graded response model, the PCM is beneficial for items with more than two response categories. Like the graded response model, it assumes ordered type responses. However, unlike the graded response model, the PCM is what Thissen and Steinberg (1986) typified as a "divide by total model". In such models, the denominator is equal to the sum of all possible numerators, and therefore the chance of a testee giving theta level scoring in a particular category is obtained directly. Another distinction between the PCM and the model of graded response is that the former may be part of the *Rasch* group and a discrimination parameter may not be included in the model.

The specific polytomous item is a series of related sequential response types as suggested by master ‘steps’. A responder is either correct or incorrect in each step of an item. An individual's type score is the sum of his or her step scores, i.e., the amount of steps passed. Masters outlined the likelihood of a specific type score as:

$$E_{iy}(\varphi) = \frac{\exp\left[\sum_{j=0}^{y}(\varphi - b_{ij})\right]}{\sum_{h=o}^{m_i}\exp\left[\sum_{j=0}^{h}(\varphi - b_{ij})\right]}(y = 0,......m_i), \qquad 2.8$$

Where b_{ij} represents the difficulty of the step connected with the type score, j in item i; and, m_i is the highest likely score on item i. However, the types of every response need to be arranged accordingly when adopting the PCM, except for the step difficulties that do not necessary need to be ordered, i.e., reverses are allowed.

2.3.5. Generalized Partial Credit Model

The generalized partial credit model (GPCM) was proposed by Muraki (1992) to build on the PCM. In contrast to the PCM, the generalized partial credit discrimination parameter is allowed to vary across items. In the GPCM, the probability of a particular type score *x*, for giving theta is outlined as:

$$E_{iy}(\varphi) = \frac{\exp\left[\sum_{j=0}^{y} a_i(\varphi - b_{ij})\right]}{\sum_{h=o}^{m_i} \exp\left[\sum_{j=0}^{h} a_i(\varphi - b_{ij})\right]}, \qquad 2.9$$

Where a_i is the discrimination parameter for item i, b_{ij} is the difficulty of the step associated with type *j*, ($j = 1,\ldots, m_i$). As is the case with the PCM, reversals are allowed in the GPCM.

2.4. Implementing Methods for Assessment

The process of assessing a program naturally exposes inconsistent goals; there is thus a need to adopt as consistent a system as possible that will not affect program delivery. Choosing a consistent method of assessment is very important in order to avoid an approximate result and to ensure the reliability of the results. Programs require a credible setting and participants' well-being should be taken into account in setting up a program (Hill & Betz, 2005).

The traditional "Pre-Test, then Post-Test" method is a common system that is well-known; in this process, participants are tested at the start of a program (Pre-Test) and the test is repeated after participating in the program (Post-Test). This method measures changes in participants' "knowledge, attitudes, or behaviours" as a result of the program (e.g., e-skills training). Evaluators adopt this method in order to precisely determine a participant's development as a result of the program. Other reasons for the reliability of this approach are discussed later in this chapter (Shadish *et al*., 2002).

The reliability of any assessment depends on the 'validity' of the conclusions, inferences or suggestions. Cook and Campbell (1979) describe this as the "best available approximation to the truth or falsity of a given inference, proposition or conclusion". In a nutshell, is it correct? For example, if an e-skills training program is introduced to improve basic ICT skills and participants are better able to apply technological tools to their work practice and use ICT applications more effectively, the conclusion that there is a relationship between our treatment (discipline program) and our observed outcome (participant behaviour at the workplace) is valid, or true.

2.4.1. Pre-Test then Post-Test Assessment Method

The validity of the traditional evaluation system (Pre-Test then Post-Test) was challenged by the response shift bias" identified by George Howard (1979) who noted a number of weaknesses in this widely adopted method. Response shift bias can be defined as a "change in the participant's metric for answering questions from the Pre-Test to the Post-Test due to a new understanding of a concept being taught (Klatt & Taylor-Powell, 2005).

For instance, if an e-skills training program is introduced to improve basic ICT skills, and those participating do not know that composing a text message is part of the use of a telephone application, at the beginning (Pre-Test) of the program, they might indicate that they do not know how to operate any kind of phone application. However, after completing the program, they might indicate that they know how to operate a phone application (Post-Test). This assessment method enables an evaluation of the effectiveness of the training (Winter, 1977).

If a participant indicates that they were using phone text messaging from the beginning, this might indicate more self-assurance during the Post-Test concerning their familiarity with phone applications. Therefore, the total assessment data indicates that the training program had no impact. In conclusion, the main issue concerning the traditional method of 'Pre-Test and Post-Test' is that response shift-bias cannot be rectified; thus, the results are likely to miscalculate the program's effect on the participants (Linn & Slinde, 1977).

Debate on this traditional method of assessment (Pre-Post-Test) prompted the introduction of a "retrospective Pre-Test" which is normally described as the "Post-Test then Pre-Test" system. This method is popular as both commence at the same time. It questions participants on a certain subject 'then' (Post-Test) and 'now' (Pre-Test). Questioning participants on their abilities acquired as a result of the program at the end results in a situation where their standard of assessing the changes in knowledge, skills or attitudes is consistent, and thus, not subject to a response shift bias (Rockwell & Kohn, 1989; Davis, 2003). Raidl *et al*. (2004) also note that using the 'Post-Test followed by Pre-Test' method minimizes the loss of data sets and is easier for both the administrator to conduct and for participants to undertake (Lamb, 2005).

It is important that each question in the survey is carefully structured and well phrased, as this can reduce concerns over the ‘validity’ of each of the assessment methods; both ‘Pre-Test then Post-Test and retrospective’. For example, in order to establish whether or not a parent adopts the correct way to discipline their child, they could be asked: “how often do you spank your children?” This will enable the identification of action both at the start and the completion of the program, for both the Post-Test then Pre-Test and Pre-Test then Post-Test systems. It is not useful to ask a general question such as, is it appropriate to spank a child over the age of two? Such a question is likely to render the particular item susceptible to ‘response shift bias’ because parents’ responses can change by participating in the program or they might not see it as a barrier prior to completing the program, as this will twist the outcome. If a direct question is asked, the problem of response shift bias will be controlled (Benjamin, 1982).

2.4.2. Questioning for Assessment of Learning

Socrates defined teaching as “the art of asking questions. Questioning can be a vital assessment technique and is thus a crucial skill for all teachers to develop. Studies have shown that lecturers will face up to a few million queries in their careers (Gerber *et al.*, 2003). Questions provide immediate feedback on learners’ progress and enable teachers to make immediate decisions on how to proceed with their teaching (Brooks *et al*., 2012). However, Wragg and Brown (2001) note, that the effectiveness of the questions that are posed determines the answers that they elicit; several tactics are employed in effective questioning. Questions could cover numerous topics; therefore it is important to determine their structure and pitch.

Teachers can pose a series of questions to enhance learners’ responses (Hastings, 2003). Well thought-out questions help learners to link ideas. While it is not possible to anticipate each and every question that may be asked, it is possible for a teacher to set a few questions in advance and even show these to the class at the beginning of a lesson in order to focus on the key themes for the day. Thus, teaching can be structured around a series of key questions, and additional ones can be posed on the spot to further consolidate learning. Some learners fail to respond simply because they don’t comprehend the question. Wragg and Brown (2001) argue that: It's perfectly possible to ask a good question in a baffling way.

With this in mind, the answer is often only as good as the question asked. If learners fail to grasp the question, they are likely to offer incorrect answers. Therefore, it is important to phrase the question at a level appropriate to the learners' age and skills. Direct questioning focuses on an individual (GnosisLearning, 2009).

2.4.3. Learning Goal

The primary focus of an "assessment for learning system is to set goals for student teaching (Wiggins & McTighe, 2000) in terms of "what is worthy and requiring understanding" (DeMeester & Jones, 2009). These goals are mainly determined by individual countries' educational standards. Heritage (2007) observes that the "education standards of many states do not provide a clear progression for understanding where students are relative to desired goals". Moreover, in the absence of methods to monitor progression, instructors focus on the "big question (Black & Wiliam, 2009).

Studies on goal inclinations reveal that learners might be "challenge seekers instead of challenge avoiders (Meyer, Turner & Spencer, 1997) if they are motivated by progression rather than performance. Motivational and cognitive control can perfectly describe how pupils perceive their learning goals (Brookhart, Andolina, Zuza & Furman, 2004), for instance, in their activities and levels of self-esteem when they are asked to evaluate themselves (Covington, 1992; Sadler, 1989).

The learning goal of ICT for CDWs relates to the global objective of improved quality of life adopted by the United Nations (UN). The primary objective is threefold. Firstly, to "promote societal goals such as social equity and justice. Secondly, to serve as a contract for improved service delivery to citizens. Thirdly, to serve as a tool for empowerment through citizen education as well as to deepen democracy (NeSPA, 2013).

2.4.4. Identifying the Learning Gap

The learning gap can be summarized as the gap between what learners know and what they are supposed to know. This gap lies in the difference between the learner's current knowledge and the level at which it should be in their academic career. In order to identify the learning gap, both instructors and learners need to engage in a process to assess their current status in a particular subject (William & Thompson, 2007). In the first place, such an assessment indicates the current status of the learner's knowledge which requires a different type of class test in order to gather information (Bergan *et al*., 1991). The information is then collated and analysed in order to determine the current performance status and to establish what is required in order to close the gap (Sadler, 1989).

Gaps can be described as the difference between the way things are and the way they should be. The purpose of identifying the learning gap is to make learning friendly for learners and for them not to feel that it is forced upon them. This requires a change in learning practice (Fox & Bennett, 1998). Changing pedagogy is a critical issue that is yet to be resolved in the academic sector, which makes any system that can produce results welcome (Grant, 2002). The learning practice gap describes inadequacies in a learner, which, if properly addressed, will boost their knowledge, ability and performance in order to achieve successful outcomes.

Bergan *et al*.'s (1991) study on the effectiveness of learning among individual learners at different institutions was conducted among 838 participants from less privileged families in six separate regions in the US. Formative assessment training was given to instructors on the use of an experimental group for pre-assessment, how to adopt observational methods to assess current development and how to use diagnostic assessment to pinpoint every learner as learning progressed. Improvements in reading, mathematics and sciences were observed and it was found that the 'experimental group' had higher cognitive gains than the control group.

Moreover, in the 'experimental group' only one in 17 learners required specific attention and training. For the control group, one in four or five learners had to be placed in a special training program. The researchers noted that as a result of conservative teaching, many pupils were described as underdeveloped and a number were required to attend special training without reasonable evidence.

In line with Sadler (1989) the NeSPA training adopted a system that first collated and analysed information about the CDWs to establish the current status of their ability in order to identify the gap before designing the pedagogy of the training program. Furthermore, the system of pre-assessment was adopted for this study to evaluate the gap and the effectiveness of the training program offered to CDWs.

2.4.5. Eliciting Proof of Learning

For assessment to be effective, it is essential to gather quality proof of learning. Heritage (2010) notes that no single method to obtain evidence of learning is better than another. An appropriate method aims to gather evidence in accordance with the learning goals, considers the skills and ideas imparted by the given teaching, and provides more detail on the knowledge process. (Heritage 2007) summarizes the different ways of collecting evidence of learning as follows: Curriculum-embedded (or systematic), planned and on-the-fly (or spontaneous). An efficient plan uses an on-going process, task, and even the fixed curriculum assessment that instructors adopt to design their teaching to produce evidence between the teaching semesters; for example, using science articles, each semester's questions, and analysis gathered during the lecture process.

In designing the teaching process, instructors design questions ahead of the lecture to prompt students' reasoning, or to foster learner interaction in order to promote insight during the course of the program. Natural assessment can be introduced by instructors; this is not planned but arises during class to provide evidence of the knowledge learners have acquired thus far. For example, during class, learners might say something that does not relate to the course work and this might prompt the lecturer to ask further questions in order to determine their level of learning.

2.5. E-Skills and ICT Literacy Competence

The ability to utilize technologies is often defined as e-skills. ICT literacy has many significant components which this broad formulation fails to recognize. While being able to apply technology (technological skills and literacy) is an aspect of e-skills; to define e-skills simply as a technological skill overlooks the scope of this concept. ICT literacy concerns four major components of equal ranking. These are quandary-solving skills, general literacy, and information literacy integrated with technological literacy (Panel, IL, 2002; Panel, DSA, 2007; Katz, 2013).

General literacy has to do with traditional literacy (the ability to read and write) and numeracy (using numbers); while quandary-solving skills is the ability to able to use the knowledge formed from one's talent to solve or respond to problems. The ability to recognize the need for information and the talent to access, identify, locate, use and evaluate information from the web is known as information literacy (ALA, 1998; 2000). According to the ACL (2000), technological literacy refers to the ability to effectively utilize computer databases, manage and present information, storing, word processing and presentation software.

E-skills are therefore defined as the ability to use digital technology and networks, create, integrate, evaluate, and manage information and being able to communicate in line with the moral or legal prescriptions controlling the use of electronic data in a knowledge society (Panel, DSA, 2007). Exploiting digital technology for analysis, and evaluating, organising and communicating knowledge, as well as being able to understand the legal and moral rules relating to access and the use of information technology requires both ability and skills (ACL, 2000). These range from easier skills to use ICT in day-to-day activities to the acquisition of the skills and ability to exploit ICT to perform advanced tasks. The ALA (1998) defines an ICT literate person as someone that is able to "Determine the nature and context of information needed; access the needed information effectively and efficiently; evaluate the information and its sources critically and incorporate selected information into his or her knowledge base and value system; use information effectively to accomplish a specific purpose; and understand many of the economic, legal and social issues surrounding the use of information and access and use information ethically and legally".

E-skills have had a major impact on society and ICT literacy is thus one of the key competencies required in the workplace. Hence, there is a need to develop a framework to assess such skills. Various frameworks currently exist to measure e-skills and competency. The International Panel on ICT literacy (2007) proposes five considerations in developing such a framework:

i. Integrate: "interpreting and representing data that has got to do with the skill to summarise, compare and contrast";
ii. Access: "knowing the method of retrieving information and therefore the ability to retrieve the information";
iii. Evaluate: "judging the connection, quality and quality of information";
iv. Manage: "applying an existing organisation or classification scheme";
v. Create: "generating data by adapting, applying, designing, inventing or authoring data".

In 2003, the United States Higher Education ICT Initiative used these components as the basis to develop a proficiency model. Two components were added. The seven components are: Outline, Access, Communicate, Evaluate, Create, Manage, and Integrate. These seven systems were associated with three main aspects: cognitive, technical and ethical. Instructional studies that have investigated e-skills competence (ICT literacy) have commonly adopted this model for evaluation. In line with efforts to bridge the global digital divide, the International Panel on ICT Skills (2001) advocated that governments, business and educators conduct research on the extent of ICT skills at all levels (national and international). It was hoped that this would provide clarity on the distribution of ICT skills across the globe and assist stakeholders to adopt policies that promote such skills. The Panel also called for research on different instructional methods that could result in a move from the 'stand-alone-ICT' course approach to an integrated method that will enable students to gain meaningful ICT skills.

The UN and the G8 group of industrialized countries were the first to highlight the concept of "Information Communication Technology for Development (ICT4D)" as a global development priority. ICT is regarded as a significant productive force for the socioeconomic development of communities in both rural and urban areas. It is generally accepted that technology underpins the unprecedented levels of prosperity enjoyed by the developed countries of the world.

Rapid advancements in ICT have led to rising standards of living, increased literacy levels, improved health and life expectancy, better security, increased access to information, and widespread opportunities for connectivity as well as accelerated development (Hilbert *et al.,* 2010; Bajunid, 2012). "ICT enables socioeconomic development with the Internet and cloud computing technologies playing important roles in changing the world. ICT enables communities to fully participate in the global knowledge economy and to play key transformational roles in the information society. ICT is undoubtedly the panacea for effective delivery of innovative services, which are important for successful global integration" (Hanna, 2003; Rahman, 2008; Weerakkody *et al.*, 2009).

2.5.1. The E-Skills Challenge in South Africa

The e-skills challenge is generally concerned with users' inability to meaningfully apply ICT in practice. This is predominantly caused by individuals' low level of knowledge, skills and education. The general challenges confronting people residing in rural and disadvantaged communities often result in limited access to quality education. Children abandon schooling at an early age due to the low quality of schools and the demand for unskilled workers in rural communities. The majority of these individuals struggle to complete their high school education and often migrate to the urban areas in search of jobs with better pay and working conditions. Large numbers of people living in rural communities are considered illiterate; thus human capacity is a major challenge in these communities.

Stakeholders have identified ICT use as a possible tool to improve service delivery by CDWs and to encourage citizen development towards a knowledge driven society. The lack of appropriate skills was the main reason for South Africa being ranked much lower in 2012 than in 2007 in the global e-readiness report by World Economic Forum (E-SI, 2013).

The literature on ICT4D notes that skills, which inevitably include e-skills, are important in addressing socioeconomic problems such as poverty, unemployment and inequity (Heeks, 2008; Unwin, 2009; Ashraf and Malik, 2010; Bankole & Osei-Bryson, 2014). According to the World Economic Forum (WEF) (2009), there are six pillars of ICT, including e-skills that play a major role. Taylor *et al.* (2013) note that, "best-practice countries have a solid base of ICT technical skills and a good level of broader science and mathematics education. Intervention to improve ICT-relevant skills includes focused training, certification and pipelines to university graduates in engineering and IT fields".

Knowledge of how to use ICT, the quality of ICT usage and the integrity of the actual usage of ICT are important indicators in assessing the impact of ICT. The International Telecommunication Union (ITU) developed a digital access index (DAI) to measure the general capacity of individuals within a country to effectively use ICT (Barzilai-Nahon, 2006; Bruno *et al.,* 2010). "The ICT development index (IDI) is a framework to measure the impact of ICT in terms of readiness, usage intensity and the capacity to use ICT. These indexes (DAI and IDI) emphasize the importance of e-skills as a resource for effective ICT usage. The CDWs in KZN province were provided with laptops and USB internet modems to enhance their service delivery efficacy using ICT. In order to maximize the several benefits of ICTs, it was necessary to offer some e-skills training to help achieve the desired outcomes". (Olugbara *et al*., 2014)

In South Africa there is a gap between the capability (skills) of communities to benefit from delivered services and the service delivery efforts of the government. "Government services at national, local and provincial levels do not always reach the intended recipients in an effective or appropriate manner. This is attributed to a number of factors, including a shortage of ICT related skills (e-skills) at local government level as well as human resource management. The e-skills challenge has been identified as a serious challenge for South African society and thus calls for appropriate interventions". (Olugbara *et al*., 2014)

2.6. Summary

In summary, the definition of ICT achievement cannot be confined to the mastery of technological skills, but should be extended to the integration of technological skills with traditional literacy, numeracy and other problem-solving skills. These integrated parts present the platform to measure e-skills. Therefore, the instruments used to assess ICT literacy must include them. In view of the need for ICT literacy at the workplace, there is a need for e-skills (ICT literacy) to be a part of the assessment domain for teaching certification, education and career readiness.

Given the various value-added models, this review covered basic as well as advanced education for a clear-cut understanding of value-added measures. The evaluation considered each model's strengths and weaknesses. It also examined the most suitable factors to consider in selecting a value-added model for a given knowledge set and education context and the major problems in improving the selected value-added models.

Value-added measures will provide policy makers and prospective learners with strong evidence of students' learning in academic establishments. Steedle (2012) also suggested that "it could be used internally by institutions to investigate ways of enhancing general education programs or the final intellectual skills of their learners. The results obtained from the value-added measure will enable institutions to determine the strengths and weaknesses in their service offerings and to learn more about how to achieve learning outcomes through benchmarking against other establishments that admit students with similar entry academic competence".

The value-added scores that estimate the institution's effect on students' growth will vary depending on the type of value-added model implemented and its specifications (Banta & Pike, 2007; Klein *et al*., 2007; Steedle, 2012). The selection of an acceptable value-added model is also determined by the costs, benefits and weaknesses of each model and their relationship with the following:

i. “Statistical and methodological problems,
ii. the properties of the information available (i.e., the points in time when the information is collected and therefore the range of observations at a particular time),
iii. the modelling complexity,
iv. difficulties of interpretation,
v. the resources required for implementation, and
vi. the policy goals of a value-added activity (e.g., accountability or improvement).” (Steedle, 2012)

A critical review of the literature on assessment methods indicates that there are strengths and weaknesses in the standard for the Pre- and Post-Test as well as the methods adopted to collect data from program participants. In general, both methods focus on the need to assess participants from the start of the program to completion. The debate among practitioners, analysts and researchers focuses on whether or not the preferred instrument collects information at two separate points in time or once at the end of the program.

This chapter highlighted the strengths and weaknesses of each approach. The choice of method is determined by the context and the type of program to be delivered, the sensitivity of the program content, participants’ comfort levels, and educators’ confidence in gathering knowledge, and time and financial constraints. The required data analysis skills and reporting need to be clearly stated beforehand by program funders. This will inform decisions on the style of analysis.

Many scholars believe that response shift bias can be reduced with the Post-Pre-Testing technique due to the fact that it is responsible for changes in individual knowledge deriving from program content; this enables the identification of what the individual acquired as a result of the training program (Rockwell & Kohn, 1989). The result will be reliable and accurate as participants will accurately demonstrate what is being acknowledged (Davis, 2002). Moreover, using a measuring instrument on one occasion is advantageous in that it reduces the time spent on administering assessments.

Validity issues can also arise with the Post- then Pre-Testing technique and these should be taken into account in adopting this assessment method. The question, “what are we attempting to measure?” is the most important consideration when deciding on an assessment technique. If the outcome (changes in people's behaviour) is the objective of the assessment, the Pre- then Post-Testing method is the most widely accepted method that can measure changes between two different periods. However, if the objective is to measure how an individual comprehends the changes required in terms of skills, information, attitudes or behaviour, the adaptive method for this kind of knowledge is the Post- then Pre-Testing technique.

It is important to note that all self-reported information is subjective to some extent. The Pre-Test then Post-Test method measures behaviours or actions at a two distinct periods of time through well-expressed questions or statements. If it uses similar questions or statements, the retrospective instrument will provide individuals' views on changes in their behaviour in the given period of time. In general, the Pre- then Post-Testing technique is the most reliable method if the outcome changes required by the program administrators or funding agency (government) are quantitative, as it enables every change to be recorded and is a rigorous and reliable assessment method.

The literature notes that Bock's (1972) nominal type model is the most widely accepted polytomous model of IRT, and its relationships with dichotomous models and different types of ordinal polytomous models of IRT have been investigated. As shown in Ackerman's (1998) study, model variations in polytomous IRT models have a theoretical basis and are rational. However, the way items are scored will determine which model of IRT should be adopted for ability estimation. If an improper model of IRT is applied, specification error will arise and bias will be introduced in the ability estimation.

Scoring items dichotomously will eliminate the variations between the three models of IRT (Mellenbergh, 1995). Mellenbergh (1995) notes that, the test is polytomously compared while it is dichotomously scored for the multiple-choice items. The assumption is that the parallel rule is adopted for scoring each item; therefore, the PCM of the ordinal polytomous IRT model is solely used for comparison. Multiple-choice was adopted for the modelling of guessing results in a polytomous IRT model (Thissen & Steinberg, 1989). Bock's (1972) model studies the level of bias if the ordinal nature of the response categories is not stated.

CHAPTER THREE

THEORETICAL FRAMEWORK

This chapter discusses the theoretical background to the study. The importance of pre- and post-assessment as an important step in measuring the effectivity of training is discussed.

3.1. Introduction

Suskie (2010) and Hake (2007) note that there is no consensus among scholars on the best methods to use to assess learning in higher education. Bond (2009) notes that Pre-assessment and Post-assessment evaluation is a logical approach as determining the skills or knowledge an individual has acquired over a given session (term) requires the use of the same or a similar instrument to assess what the person knew at the beginning of the session (term) and at the end. Rogosa (1995) and Willett (1989, 1997) provide a theoretical basis for this technique and show that frequent Pre-assessment and Post-assessment significantly improves the reliability of this approach.

This multi-stage assessment involves dividing the main course into several distinct teaching sessions. The sessions are separated by carrying out Pre-Post-teaching assessment using the Post-assessment of one session as the Pre-assessment of the next successive session (Fasasi and Heukelman, 2014). The Pre-assessment facilitates an understanding of the level of knowledge and skill before teaching, while the post-assessment indicates the extent to which the teaching improved the knowledge and skills levels. An overall review is required to determine whether or not exposing students to coursework material over many teaching sessions increases the possibility of them harvesting and retaining basic knowledge. Since student performance is expected to vary across each teaching session, there is a need to continuously balance both their acquisition and retention efforts by using a marginal review to determine the extent of the flexibility of the course design. The approach used to weigh variation in student performance is an explanatory characteristic of any Pre- or Post-assessment strategy (Fasasi and Heukelman, 2014). The most commonly-used index to evaluate the variation in group performance between the Pre-teaching assessment and the Post-teaching assessment is

$$q = \frac{\theta_{post-test} - \theta_{pre-test}}{1 - \theta_{pre-test}} \qquad 3.1$$

Where $\theta_{post-test}$ = average score of the post-test, $\theta_{pre-test}$ = average score of the pre-test and maximum score = 1.

Hovland *et al.* (1949), as cited in Dellwo (2010), used q as a ratio to measure the effectiveness of using instructional films while teaching. Hake (1998) used "q to evaluate the effectiveness of adopting several teaching techniques in an introductory physics courses". Subsequently, Meltzer (2002) used "q to investigate the relationship between concept learning in physics and mathematics preparation". The literature notes that the participant with the biggest value of q has a higher rate of comprehension than other subjects.

Unfortunately, this assessment rule as shown in equation (3.1) could result in counterintuitive conclusions as the outcome might be against the hypothesis. Therefore, to deal with such situations another alternative assessment rule is introduced by decomposing equation (3.1) into component measures:

$$q = Q - \lambda T \qquad 3.2$$

Q represents normalized gain quantifying the probability that an error in the group's pre-teaching assessment is addressed and corrected in the post-teaching assessment (the questions they answered incorrectly before teaching were answered correctly after teaching).

T represents normalized loss, quantifying the probability that in the group's pre-teaching assessment all correct responses are repeated as incorrect in the post-teaching assessment (the questions they answered correctly before teaching were answered incorrectly after teaching, demonstrating a loss of knowledge).

λ is a non-negative parameter representing the renormalization factor that depends on the pre-teaching performance of the whole population:

$$\lambda = \frac{\theta_{pre-test}}{1-\theta_{pre-test}} \qquad 3.3$$

* λ is the Scaling factor

Using (3.1), (3.2) and (3.3)

$$\frac{\theta_{post-test} - \theta_{pre-test}}{1-\theta_{pre-test}} = Q - \frac{\theta_{pre-test}}{1-\theta_{pre-test}} T \qquad 3.4$$

$$\theta_{post-test} - \theta_{pre-test} = Q(1-\theta_{pre-test}) - \theta_{pre-test}.T \qquad 3.5$$

10

The scaling factor (3.3) is a non-negative parameter whose value is larger than 1 if $\theta_{pre-test} > 1/2$, equal to 1 if $\theta_{pre-test} = 1/2$, and smaller than 1 if $\theta_{pre-test} < 1/2$. The scale λ is referred to as the group's aspect ratio and specifies the probability that the whole group gives a correct answer in the pre-teaching assessment.

3.2. Measurement of Course Effectiveness

The following steps were taken to assess the relative effectiveness of the training program and to measure each participant's progress. Figure 3.1 shows the two groups A and B of the participants involved in the training program.

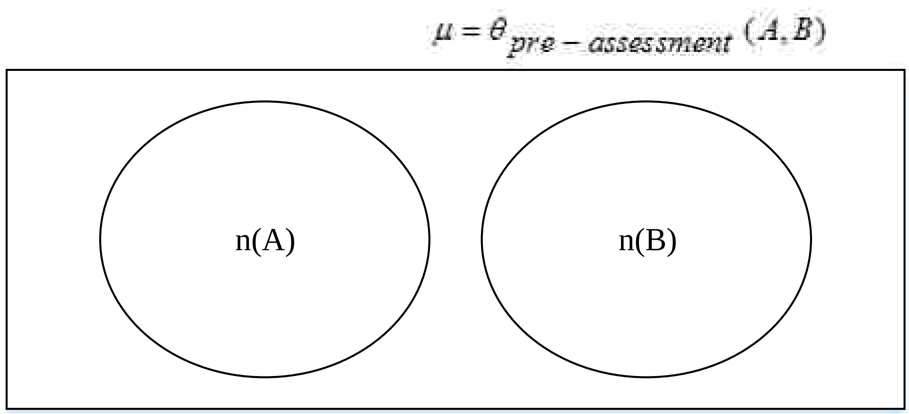

Figure 3.1: The Venn diagram of Control Group and Experimental Group (Fasasi and Heukelman, 2014)

Where A represents the control group of the Pre-teaching assessment; this is the group of participants who have additional knowledge in the Pre-teaching assessment. Therefore $n(A)$ is the number of participants in the control group. B represents the experimental group; this is the group of participants that needs more attention in the teaching session, where the instructor focuses on the teaching method and $n(B)$ is the number of participants in the experimental group. $n(A \cup B)$

represents the total number of participants involved in the assessment exercise (Fasasi and Heukelman, 2014). This is expressed in equation 3.6.

$$\theta_{pre-assessment}(A,B) = n(A \cup B) = n(A) + n(B) \qquad 113.6$$

The assessment exercise is categorized into two, namely, Pre-assessment ($\theta_{pre}(A,B)$) and Post-assessment ($\theta_{post}(A,B)$)). Equations 3.7 and 3.8 show the relationship between the results of the Pre-assessment and Post-assessment exercise for both the control group and experimental group.

$$\lambda_{pre}(A,B) = \lambda_{A_{pre}} + \lambda_{B_{pre}} \qquad 3.7$$

$$\lambda_{post}(A,B) = \lambda_{A_{post}} + \lambda_{B_{post}} \qquad 3.8$$

Where $\lambda_{A_{pre}}$ represents the result of the participants in the control group before training $\theta_{pre}(A,B)$; $\lambda_{B_{pre}}$ is the result of the participants in the experimental group before training $\theta_{pre}(A,B)$; and $\lambda_{pre}(A,B)$ is the result of all the participants before training $\theta_{pre}(A,B)$; $\lambda_{A_{post}}$ represents the result of all the participants in the control group after training $\theta_{post}(A,B)$; $\lambda_{B_{post}}$ is the result of the participants in the experimental group after $\theta_{post}(A,B)$; and $\lambda_{post}(A,B)$ is the result of the participants after training $\theta_{post}(A,B)$.

$$\delta(\lambda_{B_{post}}, \lambda_{B_{pre}}) = \lambda_{B_{post}} - \lambda_{B_{pre}} \ \ iff \ \ \lambda_{B_{post}} > \lambda_{B_{pre}} \qquad 3.9$$

$$\delta(\lambda_{B_{post}}, \lambda_{A_{pre}}) = \lambda_{B_{post}} - \lambda_{A_{pre}} \ \ iff \lambda_{B_{post}} > \lambda_{A_{pre}} \qquad 3.10$$

It is essential to measure the knowledge acquired by each group at the end of the assessment exercises. Equation (3.9) shows the measurement of the results of the Post-assessment for the experimental group minus the results of the Pre-assessment for the same group. This establishes the level of the knowledge acquired by the experimental group by the end of the training program. Equation (3.10) shows the measurement of the results of the Post-assessment for the experimental group minus the results of the Pre-assessment for the control group. This assesses if the experimental group and the control group are at the same knowledge level. A positive value from the equation (3.10) will indicate that the training program was effective and met its predefined objectives. (Fasasi and Heukelman, 2014)

3.3. Multi-stage Assessment

Many Pre- or Post-assessments use only one instrument session paused or separated by similar or very similar Pre- and Post-teaching assessments (McConnell *et al.*, 2006; Libarkin *et al.*, 2006; Meltzer, 2002). However, single-stage approaches that depend on two assessments are less accurate because insufficient data is gathered to determine whether the knowledge is gained as a result of the training, or whether the learner had already had this knowledge or skill, but had forgotten it and therefore had to relearn it.. A single Pre- or Post-exercise is not able to detect performance differences between an individual that learns a key skill and forgets it and an individual who did not learn the same skill at all. Another weakness of the single-stage approach is its inability to distinguish between an individual that maintains Pre-teaching knowledge during the course of the session and one who forfeits knowledge and then relearns it during the learning session or term. (Fasasi and Heukelman, 2014)

Multi-stage assessment schemes monitor variations in learning and also fine-tune the process of assessment by integrating various single-stage systems. The two-point approach shown in Figure 3.2 is capable of detecting a one-time loss and subsequent gain or reacquisition of course material as well as one-time acquisition followed by the loss of the course material. It is important to note that such an inter-session diagnostic assessment (T_1) produces the Post-teaching assessment of the first stage as well as the Pre-teaching assessment of the second stage.

From Figure 3.2, the first session of a multi-stage assessment system is grouped by Pre- and Post-teaching assessments T_0 and T_1. The second stage is grouped by T_1 and T_2. The diagnostic assessments are similar instruments designed to assess the learning of key skills and concepts (Fasasi and Heukelman, 2014)

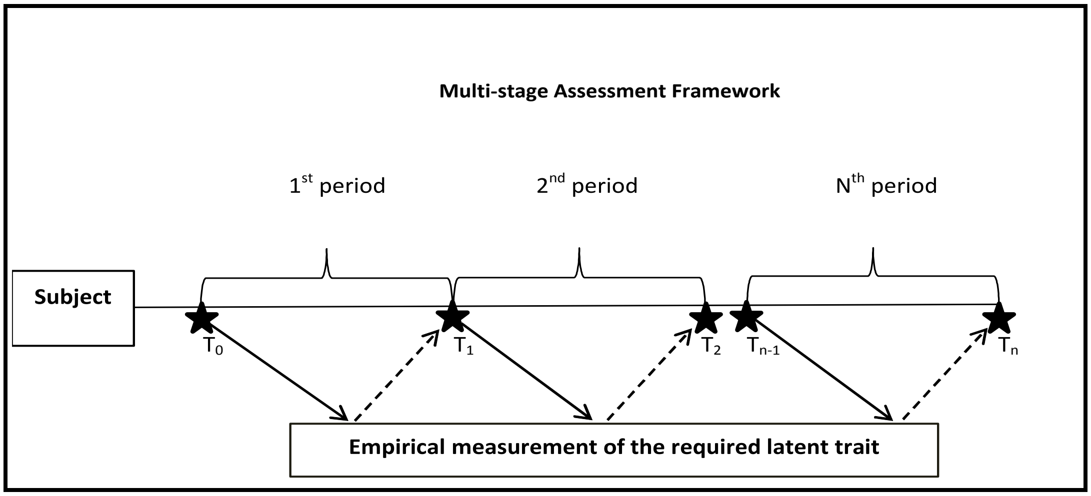

Figure 3.2: The empirical value-added measurement

3.3.1. Marginal Analysis of the Multi-stage Systems

The normalised change component is used in marginal analysis to tabulate fluctuations in performance, subject to the Pre-teaching levels at each of the stages of a multiple-stage system. Fluctuations in effectiveness between one teaching session and the next for a given course can be analysed using this method (Fasasi and Heukelman, 2014).

It is essential to note that the standard of determining effectiveness varies between sessions for marginal analysis; Figure 3.2 shows that marginal analysis of the two-point approach could show knowledge gained and knowledge lost between T_0 and T_1 and also between T_1 and T_2 in order to analyse fluctuations in effectiveness for a single course. However, circumstances to improve the effectiveness of the first teaching session for the second teaching session indicate that there is greater course effectiveness in enhancing knowledge for the T_1 performance than if it was compared to the T_0 performance.

Marginal analysis of a two-point approach could also be used to compare the effectiveness of two different courses in improving learning relative to T_0 and T_1. In this case, it is possible that one of the two courses is more effective in improving learning relative to T_0 while the other is more effective in promoting learning relative to T_1 (Fasasi and Heukelman, 2014)

3.3.2. Collective Analysis of the Multi-stage System

Cumulative analysis tabulates the change in performance in the overall successive stages, evaluating gains and losses in the preliminary Pre-teaching assessment and proceeding to the Post-teaching assessments. In contrast to marginal analysis, the performance on the initial T_0 is stable and based on changes in successive sessions following T_0 to $T_{1,}$ T_0 to T_2, ……..T_{n-1} to T_n.

This method can be adopted to measure the effectiveness of a certain course along the single session between T_0 to T_1 and its effectiveness along two sessions between T_0 to $T_{2.}$The analysis of their performance in the basic diagnostic Pre-teaching assessment, T_0, will enable participants to improve their performance. However, the method can also be adopted to review the effectiveness of two different courses in improving learning along the first two to three, and more teaching sessions succeeding the basic diagnostic Pre-teaching assessment, T_0 (Fasasi and Heukelman, 2014).

3.4. Summary

In summary, several data-driven studies have shown that there is always an improvement between the Pre-Test assessment and the Post-Test assessment. The empirical value-added measurement model (Figure 3.2) developed for this research shows that there will be a significant improvement in the performance of the participants at the final Post-Test of multi-stage assessment compared to the traditional Pre-Test and Post-Test (single point). This high level of performance can be attributed to efficient planning during the training program. As noted with regard to the model in Figure 3.2, Pre-Test assessment involves testing the participants before the commencement of the training program (T_0) and continues performing Post-Test assessment testing for participants at a subsequent interval of the program (T_1, T_2……..Tn) This enables the knowledge, attitudes, or behaviour of the participants to be evaluated" (Fasasi and Heukelman, 2014). As anticipated, most participants at the final stage of Multi-stage Assessment performed exceptionally well, but it was observed that those that failed to perform exceptionally well at the end of the training season did not complete the Post-Tests Training seasons.

Furthermore, a large survey of pre/post assessment data relating to an introductory physics course (Hake, 1998) evaluated the average in normalized change for the sections which were subjected to the traditional (T) assessment method and those subjected to interactive engagement. He noted that increased use of interactive engagement improved the results. Those that introduced a bit of interactive engagement (IE) stood at g_T ~ 0.23 and those that significantly introduced interactive engagement (IE) system stood at g_{IE} ~ 0.48. The variation between these results is visible and noteworthy because the result of the interactive course is double that for the traditional course. Hake (1998) concluded that: “Classroom use of IE strategies can increase mechanics-course effectiveness well beyond that obtained in traditional practice.

CHAPTER FOUR

RESEARCH METHODOLOGY

This chapter discusses the research approaches, research methods and data gathering procedures employed for this study.

4.1. Introduction

The discussion and interpretation of a research approach can be fully recognised by understanding the theoretical framework (Mertens, 2005). However, researchers can select either a single approach or a combined approach (Cohen, Manion & Morrison, 2004). The term 'approach' can be described in relation to three elements, namely: a belief about the nature of knowledge, a methodology, and criteria for validity (Mac Naughton, Rolfe, and Siraj-Blatchford, 2010). According to Mackenzie & Knipe, (2006), their study shows that the popular models discussed in literature includes positivist, constructivist, interpretivist, transformative, emancipatory, critical, and practicality. Constructivism and naturalism are argued to be the two most dominant methodological approaches (Moses and Knutsen, 2007). Despite this, there are various approaches identified by different experts and grouped into four main areas: positivist, post-positivist, interpretivist and humanistic (Della Porta & Keating, 2008). According to Kim (2003), positivism, interpretivism and critical science are the three research models outlined as the primary research models. For this research a constructivist approach was used.

The constructivist approach, recognizes both the observer and society as partners in constructing knowledge and the fact that any phenomenon cannot be observed objectively, because individual experience influences observations. Constructivism accepts reality as a product of interaction between human intelligence and the real world. Although there are some overlaps, constructivist research generally uses more qualitative approaches and methods than quantitative, but not exclusively. Creswell (2009) mentions three main types of research design: qualitative, quantitative and mixed methods. The terms refer to the research approach and the research methods related to the approach which are selected (Mackenzie and Knipe, 2006; McMillan and Schumacher, 2006). In spite of different terminology that has been use to describe these approaches; it is widely acceptable that the two most common approaches in social science research is qualitative and quantitative approaches (Morgan, 2007). According to Moses & Knutsen, (2007), these two approaches can be argued as the extremities of the spectrum.

4.2. Quantitative Approach

Quantitative research is a means of testing objective theories by examining the relationship among variables. In turn, these variables can be measured, typically on instruments, so that numbered data can be analysed using statistical procedures. Scholars that engage in this form of inquiry make assumptions about testing theories deductively, building in protections against bias, controlling for alternative explanations, and being able to generalize and replicate the findings (Creswell, 2009).

According to Creswell, (2003); quantitative method of analysis can also be describe as positivist/ Post-positivist research, empirical science and scientific method. The post-positivist approach challenged the ability of being positively sure about the newly acquired knowledge (Phillips & Burbules, 2000). The quantitative research approach is influenced by a positivist model and can be based on the assumption that the reality is grounded as an objective ontological structure also that scientific tools can be used to measure and explain this truth. "Reliability, validity and generalizability" Creswell, (2003) are the main focus in evaluating with quantitative research.

Despite the widespread use of quantitative approaches they have been subjected to some criticism. This includes general criticism of quantitative research as a strategy, and criticism of its epistemological and ontological foundations as well as criticism of the specific methods used as part of quantitative research" (O'Brien Maguire, 2011). Cohen, Manion and Morrison (2004) agree with Bryman (2012) and mention numerous writers that are critical of the deterministic assumptions that underpin positivism, and therefore quantitative research, and the disregard for factors such as choice, freedom and individualism.

Despite the criticisms levelled at the quantitative analysis, it was applied in this study with regard to the analysis of the data to quantify the effectiveness of the intervention, i.e., training in ICT offered to CDWs. The negative effects were somewhat moderated by using a mixed methods approach.

4.3. Qualitative Approach

Qualitative research is a means to explore and understand the meaning individuals or groups ascribe to a social or human problem" (Creswell, 2013). The research is focussed on solving new problems. Data is typically gathered in the participant's own environment and the "data analysis inductively builds from particulars to general themes" with the researcher interpreting and trying to understand the meaning of the data. "Those who engage in this form of inquiry support an inductive style, a focus on individual meaning, and the importance of representing the complexity of a situation (Creswell, 2013).

Qualitative research is also a widely adopted research approach; it represents a shift in the social science research with new interest in the past and a move in research from a marginal and to a more equitable position (Morgan, 2007). According to Morgan, (2007), this shift can be described as the outcome of "dedicated efforts by advocates for a particular point of view". The argument to which approach is more appropriate can be based on the nature of research and therefore brings a challenge to conventional wisdom.

Qualitative researchers are interested in perceptions of reality rather than reality itself and are therefore open to the possibility that people may observe the same thing differently. As such they focus on the reflective and idiosyncratic nature of knowledge (Moses & Knutsen, 2007). The guidelines for conducting qualitative research are generally less prescriptive than those for quantitative research.

The self-reporting questionnaire, which was used as a data gathering tool in this study and was adapted from a Eurocentric framework, the European e-Competence Framework for ICT Users-Part 1 (CEN, 2013) to fit the work environment of CDWs, was qualitative in nature. The qualitative approach allowed participants and observers the flexibility to interpret results and findings in different ways. Using different tools and perspectives to analyse the data enabled improved understanding of the complexities of the nature of ICT training.

4.4. Quasi-experimental research

There are different types of quasi-experimental research design. The design followed in this study consisted of:

One group pre-test / post-test design

Figure 4.1: Quasi-experimental research design

The quasi-experimental design was adopted because it was regarded as suitable to address the study's objectives and it also addressed several of the challenges of random assessment designs. Participants completed a self-reporting questionnaire, were given ICT training, and completed a second self-reporting questionnaire.

The study's central research questions were:

i. Which ICT skills do CDWs require to use in their work environment to meet their KPIs?
ii. Which ICT skills require improvement to enhance CDWs' productivity?
iii. How can the impact of the training be measured?

As previously highlighted, the research design employed to examine the connection between the e-SI training program and the CDWs' effective use of ICT measured the CDWs' e-skills ability before and after the training program and also quantified the effectiveness of the e-SI training program.

4.5. Data collection

Participants for the training were selected by the employer, who is provincial government, based on the areas within which the CDWs function. The research design was therefore limited to what was required by the employer. The study was conducted using CDWs that are part of the KZN cohort.

4.5.1. Population

In the South African context, CDWs are defined as "community-based resource persons who collaborate with other community activists to help fellow community members to obtain information and resources from service providers (Handbook for Community Development Workers, 2006). The CDWs are a special type of participatory change agents who live and work in the communities from which they are selected, and are answerable to their community for their activities. “They are financially and functionally supported by a range of government spheres and departments, particularly local government. Although they are specifically trained and certificated for their role, they have a shorter training period than professional development workers who obtain tertiary qualifications” (Handbook for Community Development Workers, 2006).

As noted earlier, the minimum qualification to become a CDW is NQF level 4 (Grade 11) or equivalent. The basic education and training of CDWs is accomplished by them first undergoing the learnership programme organized by the South African government for every would-be CDW. Most CDWs are required to complete a learnership process of one year during which they are introduced to “some theoretical work, although most of the emphases is on community-based learning and practical experience” (Handbook for Community Development Workers, 2006).

4.5.2. Sampling method

The training which was provided was at the request of the national and provincial government and was funded by the national government. Participants were selected by the employer, provincial government, based on the areas within which the CDWs function. The research design was therefore limited to what was required by the employer.

The cluster sampling method was applied to the whole KZN catchment area. The selection of the first cohort of participants was based on specific areas within the province identified by provincial government, and can therefore be classified as convenience sampling informed by the stakeholders. A total of 187 CDWs was selected for the training intervention from different wards within KZN.

4.5.3. Sample size

This case study was designed to capture all 469 CDWs who were assigned to communities in KZN at the time. Three hundred and twenty-seven CDWs from different wards completed the questionnaire for the Pre-Test assessment with the proportions based on the number of CDWs in each area. 214 of the CDWs completed the training and 187 participants completed the questionnaire for the Post-Test assessment.

4.5.4. Data gathering instrument

According to Babbie (2010) questionnaire can be defines as an instrument specifically designed to elicit information that will be useful for analysis. A questionnaire is an instrument use for gathering information by putting a direct question to people on issues relating to the research (Denscombe, 2014). A survey questionnaire is used for descriptive, explanatory and exploratory purposes (Babbie, 2010). Questionnaires are a useful method of data collection when there are a large number of respondents in many locations; when the information required is fairly straightforward; when there is a need for standardised data and when respondents are able to read and understand the questions (Denscombe, 2014). Questionnaire should be clear in terms of its purpose and what needs to be covered in order to achieve its objectives; pose appropriate questions so as to elicit the kind of data required; and gather empirical data" as stated by (Cohen *et al,*. 2004).

The questionnaire (Appendix 3) contextualized the UNESCO (2011) framework for ICT skills in terms of the ICT skills required by CDWs in the South African work environment. The KPIs for CDWs were used to identify their routine tasks, the performance of which could be improved through the use of ICT. The self-reporting questionnaire consisted of five sections: A – Biographical details and job description, B – Environmental details (mainly technology and Internet connection), C – Work requirements, D – Education and general technology use, and E – Self assessment of ICT skills level.

Section C on (CDWs' current use of technology) asked the participants to categorize their tasks as daily, weekly or monthly and to indicate whether or not they were accomplished using ICT. A Likert scale was used in Section E where respondents rated the level of their e-skills ability: No skill, Limited skill, Average skill, Good skill or Expert skill. In evaluating the CDWs' e-skills, the respondents' perceptions of their ability to use ICT in performing tasks within their workplace was analysed using IRT with the use of Item and Test Analysis (IATA) software. Further discussion on the actual analysis can be found in Chapter 5.

4.5.5. Implementation

The local CDW coordinators for each municipality distributed and collected the questionnaires. These were centrally collected by the regional office and subsequently collated for further analysis. The Participants completed the questionnaires under the supervision of the coordinators.

4.5.6. Training intervention

A draft ICT syllabus was constructed based on the CDWs' required tasks. The stated high level tasks of the CDW program (Handbook for Community Development Workers, 2006) are:

i. Empowerment of citizens for sustainable development
ii. Mediation and conflict resolution within communities
iii. Mobilization for active citizen engagement
iv. Creation of an enabling environment for communities
v. Forging partnerships, linkages and networks with key stakeholders
vi. Facilitation of government services and other services that can lead to a better life.

Areas where ICT could enhance the effective accomplishment of these tasks were identified and a practical syllabus was constructed to address these aspects. Meetings between the stakeholders resulted in a more refined syllabus. Study material was created specifically for this training intervention. During the delivery of the course, participants also had the opportunity to request that specific tools be included and two extra modules were added. A total of 15 modules at different skills levels was developed and made available to the participants.

Table 4.1: Assessment criteria and learning outcomes

Learning Outcomes	Assessment Criteria
Write and submit reports using electronic media to facilitate government services and other services that can lead to a better life	• Create a standard, well-formatted report using a word processor • Use email to submit a report
Effectively present information using electronic media to mobilize for active citizen engagement	• Create a presentation on the pertinent steps in a specific process
Find relevant information online using electronic media to create an enabling	• Use online searches (including mobile) to find information on

environment for communities and empower citizen for sustainable development	funding opportunities, donors and development agencies • Collate information
Help community members to communicate effectively using ICT to mobilize for active citizen engagement with elected representatives and government officials	• Facilitate mobile interaction between community members and government representatives
Access up-to-date information from different departments using electronic media to facilitate access to government services and other services that can lead to a better life	• Use websites and RSS feeds to ensure accurate information is collected
Communicate across departments, agencies and different spheres of government using electronic media to forge partnerships, linkages and networks with key stakeholders	• Synchronize calendar on mobile and desktop devices • Set up a meeting using electronic media • Set up a group email account
Keep financial statements using electronic media access to government services and other services that can lead to a better life	• Set up a financial budget using a spreadsheet

The training materials were designed by staff members from the Department of Information Technology at DUT and all training facilitators were based at DUT. Due to locational constraints, the training was provided within the province of KZN as a first step in implementing the program throughout South Africa.

The training material was arranged in 15 modules, going from basics to the more advanced use of ICT applications. The CDWs were encouraged to choose particular modules to suit the level of their competency. The 15 modules incorporated spreadsheet applications, word processing, search engine, Dropbox, Google maps, and Facebook for communities. The different modules incorporated various exercises for the CDWs to complete and eight exercises was the minimum they were expected to submit via the LMS. The CDWs were encouraged to request modules on more applications, for which modules would be developed and added to the class web site. The 15 training modules provided by the e-skills literacy training program as stated in Olugbara *et al*., (2014) were organized as follows:

i. Module 1 (keyboard) – an introductory module to help CDWs to identify the functions of the different keys on the keyboard.

ii. Module 2 (word menu) – the menu bar is an important stepping stone for many ICT applications. This module introduced CDWs to storing and retrieving files. The menu bar and the available tools were shown in a systematic way and explained.

iii. Module 3 (word tables) – tables are often used in different ways for data management. This module offered a step-by-step guide on how to create a table within a word document.

iv. Module 4 (spreadsheet) – many of the report templates used by CDWs are in spreadsheet format. It was therefore important to teach the CDWs the formulae for data analysis and the figures for reporting the results of data analysis that can be easily managed in a spreadsheet.

v. Module 5 (presentations) – CDWs are tasked with information dissemination and are required to speak to groups of people to do so. The use of presentation software could facilitate improved understanding among community members. This module focused on creating 'good' presentations.

vi. Module 6 (emails) – while CDWs have work email addresses as "xxxx@cogta", a private email address would allow them to experiment with emails and make ICT part of their everyday life. This module explained how to send and receive emails and create email addresses.

vii. Module 7 (Facebook) – being able to use Facebook would lead to confidence in using social network applications. Aspects such as privacy and ethics can be introduced and illustrated using an application such as Facebook. This module explained how to create a Facebook account and use Facebook to communicate with people.

viii. Module 8 (Facebook for community) – once Facebook for the individual has been mastered, it can serve as a communication tool within the community. Facebook is widely available on many cell phones and if CDWs could create a Facebook page for their community, this might facilitate improved interaction among community members. This module explained how to use Facebook to interact with community members.

ix. Module 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 module explained how to create and use Dropbox.

x. Module 10 (Internet search) – CDWs were introduced to effective searching techniques. They were encouraged to search for topics such as government department sites, AIDS awareness campaigns and topics of interest to their community. This module explained how search engines can be effectively used to search for information on the Internet.

xi. Module 11 (More than searching) – the integrated environment offered by the Google search engine is a powerful tool that was introduced to CDWs. Document sharing and collaboration on the same document could be effectively used among CDWs. Google drive was also covered in this teaching; the CDWs tended to find the integrated environment of Google more appealing.

xii. Module 12 (RSS feeds and web technology) – many websites show the RSS icon to indicate that RSS feeds are available. This concept and its use were explained in this module.

xiii. Module 13 (VOIP and IM) – using applications such as Skype and other technologies to communicate at a cheaper rate was discussed. The possibility of conference calls instead of face-to-face meetings using these technologies was introduced.

xiv. Module 14 (Spreadsheet charts) – during the delivery of this training, some CDWs expressed interest in spreadsheet charts and were added to the list of those that are interested in advanced spreadsheets.

xv. Module 15 (Google maps) – while discussing some of their work environments, the CDWs identified areas that were unknown to them. A session was thus offered on the Google maps engine and its application to their needs. Various applications of Google maps were demonstrated. (Olugbara *et al*., 2014)

4.5.7. Implementation of intervention training

The aim of the e-skills literacy training was to assist the CDWs to become as competent as possible in using ICT within their workplace. A Learning Management System (LMS) (Blackboard), which the participants could access from their own devices, was used to present the training in 15 modules. This was designed to allow the participating CDWs access from all the communities in KZN province. This training method allows for consistent delivery of the learning material and the reduction of device-related issues. The LMS is the platform adopted by DUT to support e-learning. The CDWs were happy with and benefited from the LMS as it is used for eliminating geographical hindrances, accommodated multiple learning styles, save travel costs, leveraged limited teaching resources and is able to scale information and knowledge. We particularly devote attention to the ability of participants on how to navigate the learning materials and provide adequate response.

The evaluation of the training of CDWs was important because any researcher who choose to conduct a research that is evidence-based requires to have an idea of the focused group and should able to give an adequate means of sharing knowledge with them.

The training was conducted for three consecutive weeks, with four days per week per group of CDWs, who attended in one of nine different locations within KZN. They accessed the materials in the Blackboard environment (Figure 4.2) under the supervision of a facilitator for each location.

Figure 4.2: ICT Training on Blackboard

The training was logically conducted in the following steps using the LMS to deliver the material in November 2013:

i. CDWs logged into the Blackboard environment and completed the informed consent form before accessing the teaching.

ii. CDWs were provided with 15 distinct teachings on ICT literacy. Each training module was paired with a Post-training task with emphasis on applying ICT to practice. The identical performance-based variables for the online task are writing reports, searching the Internet, organising data, analysing data and sending information.

iii. CDWs went through each teaching with the content written in English and they completed the exercises that were provided step-by-step for each teaching.

iv. CDWs were given the Post-training and satisfaction surveys, with the questions designed to determine their cognitive and affective behaviours.

v. The e-skills training ended and CDWs were thanked for their participation.

The venues for each training were inspected before the training actually took place. One of the biggest problems was a lack of stable Internet connectivity. Instructors had to rely on a copy of the courseware saved on USB. In some cases, this prevented the CDWs from becoming familiar with the use of the Blackboard learning system. The general feedback on the contents of the training was impressive and the CDWs requested follow-up training programs. The feedback generally indicated that the learning materials were suitable.

In total, 214 of the envisaged 476 CDWs were trained. Access to the online materials by the CDWs continued for a year after the delivery of the training. In addition to the training material being available via Blackboard, each facilitator had all the training materials on USB in case connectivity was a problem within the area where the training was conducted.

4.5.8. Data Management and Analysis

In this study, we generate a large amount of quantitative and some qualitative data. The first step in analysing data is to scrutinise the data collected at various stage of the research. We analyse data from each session and report the findings before starting with the next phase. Every data went through as thorough check by reading and re-reading in order to give the researcher a familiarity with the date for obtaining good understanding of the findings. This provides the opportunity to picture the data in line with the objective of the research.

IATA software developed in 2013 by Fernando Cartwright is the software used to analyse the data collated from the quantitative data. We document the response from various quantitative questions in a tabular format. This provides for the data to be seen efficiently and effectively measures the intended findings. Different participant group provides various amounts of data, related to those who participated in the training program and from different regions that involved in specific area of the e-SI program. However, this study adopts a mixed method, and we conducted the quantitative before the qualitative findings.

In order to have a manageable system for clarifying the acquired data a spreadsheet was used for the development. We separate the data according to the various units and documented separately, following the prompt question in relating to quantitative data from the questionnaires, and managed in sequential format in the case of focus groups. "The reduction process includes questioning the data, identifying and noting common patterns in the data, creating codes that describe your data patterns, and assigning these coded pieces of information to the categories of your conceptual framework". (Bloomberg and Volpe, 2008)

While CTT and IRT are used to assess peoples' abilities and capabilities, the main focus of both methods is to show the level of the individual's ability, along with the limitations of such ability. From the diversity of educational applications, proficiency can refer to ability, but cannot be observed directly, except with the use of evaluation theories (Khan *et al.*, 2010). The biggest advantage of IRT is that it clearly stipulates the methods to be used to determine the discriminatory level of individual item responses to a test, compared to the CTT where the probability of a response to an item might be difficult to measure (Hays *et al.*, 2000). With IRT, the probability of responses to an individual item as a function of the proficiency and item parameters can be determined. This model can also be used to determine the parameters of an individual item along with the probability of a latent trait. The ability estimate can be observed by comparing the highest value of the probability to the frequency in ability (Thorpe and Favia, 2012).

The IRT was considered an appropriate statistical tool to determine the e-skills proficiency of CDWs. It was used to analyse the responses to the self-reporting questionnaire to determine whether the questions in the questionnaire were suitable and whether the participants answered honestly.

4.5.9. Ethical Concerns

Ethical issues arise at all stages of a research process and mainly focus on protecting the participants' rights. Steps were taken to encourage honest responses from the participants and although they were identified in the pre-test questionnaire, personal information remained confidential. Participants were assured of confidentiality at all stages of the research. Respondents completed the questionnaires individually. The questionnaires were distributed and returned by the facilitators. The researcher checked the validity of the data with the establishment at all stages of the research.

4.6. Summary

This chapter presented a detailed description of the research methodology employed for this study. It began by outlining the study's objectives and went on to highlight the key issues in relation to the choice of research model. Quantitative and qualitative models were discussed and it was noted that this study adopted a mixed methods approach with a quasi-experimental method.

The selection of the sample was described, access to the research participants was outlined and the main method of gathering data, the survey questionnaire, was discussed. Ethical concerns pertaining to the study were also highlighted.

The key issue of data management was described in detail to describe the rigour of the study. The methodological approach outlined in this chapter forms the foundation for the research findings and discussion in Chapters 5 and 6.

CHAPTER FIVE

RESULTS AND DISCUSSION

This chapter presents the analysis of the data and discusses the findings. Both Item Response Theory (IRT) and Classical Test Theory (CTT) were used to analyse the results. The data on CDWs' e-skills are first analysed using IRT in sections 5.2-5.3, and subsequently using CTT in sections 5.4-5.6.

5.1. Introduction

The focus of IRT and CTT is to assess both abilities and capabilities. The objective is to locate an individual's position along some latent dimension. The biggest advantage of IRT is that it clearly states the methods used to determine the discriminatory level of individual item responses to a test, compared to CTT where the probability of a test item response might be difficult to measure (Hays *et al.,* 2000). With IRT, the probability of responses to an individual item as a function of a participants' proficiency and item parameters can be determined. This model can also be used to determine the parameters of an individual item alongside the probability of a latent trait. The ability estimate can be observed by comparing the highest value of the probability with the frequency of ability (Thorpe and Favia, 2012).

However, in using these methods in the context of educational applications, 'proficiency' refers to ability while in other contexts it might relate to anxiety, neurosis, or simply an authoritarian personality, depending on what it intends to measure. Proficiency is not directly observable, but theoretically there is no problem in measuring it. The distinct feature of IRT is its adoption of explicit models for the probability of each possible response to a test; thus, its alternative name, Probability Test Theory, may be the most critical advantage. As noted earlier, IRT determines the probability of each response as a function of proficiency and some parameters. The same model is then used to obtain the likelihood of 'ability' as a function of the actual observed responses and, again, the item parameters. The ability values that have the highest likelihood become the 'ability estimate'.

In investigating the ability/performance of the CDWs, a partial credit factor was used to analyse and determine their e-skill performance, characterized by the cue words (N) No Skill, (L) Limited

Skill, (A) Average Skill, (G) Good Skill and (E) Excellent Skill to determine the ability level using a particular skill. Each option was coded numerically, i.e., N=1, L=2, A=3, G=4, and E=5.

Another aim of the survey was to examine a CDW's skill using the partial credit method within the context of IRT that measures an individual's performance on a specific test item, which can be assumed to be proficiency (Thorpe and Favia, 2012). The relationship between performance on an item and proficiency is described by an item characteristic curve. In IRT the probability of the wrong response is simply equal to 1, thus, one can focus on the probability of the correct response. A large part of the IRT is the various possible models for proficiency.

5.2. Analysis using IRT

IRT is an item-oriented, rather than a test-oriented, approach to partial credit analysis. An IRT analysis of the e-skill of each CDW provided information about the difficulty level to generate specific knowledge in response to a particular item, and it also distinguished between different levels of knowledge specificity proficiency. Practically, little work has been examined on how an item's characteristic is related. (Khan *et al*., 2010). The findings from this analysis informed the modification of training for CDWs so that they are better skilled in ICT and are able to retrieve and present their information electronically using ICT. The responses to the items by all the participants were captured on a spreadsheet and analysed using Item and Test Analysis (IATA) software (Cartwright, 2013).

5.2.1. Estimation of Item Parameters

The PCM using IRT analysis was used as a tool to provide a better assessment of a person's performance as this model provides statistics (quantitative) as well as 'guess' and 'insight' (qualitative). It also offers the advantage of additional features which are not available using traditional statistical methods.

These item statistics provided significant information to validate the usefulness and acceptance of the individual questionnaire items (Matlock-Hetzel, 1997).

Parameters a, b and c:

- a - represents the relationship between a participant's performance on a specific item and the overall test performance of all the participants. The higher the value the more this item discriminates between participants with high ability and those with low ability
- b - represents the item difficulty, with values ranging from -3 (very easy item) to +3 (very difficult item)
- c- represents a pseudo-guessing parameter

5.2.2. Discrimination Index (Discr)

Item discrimination can be used to clarify the extent to which individual items measure the exact goal set for measuring. In a case where all participants provide a similar response to a particular item, the Discrimination Index (**Discr)** can be used to compare the ability of an item to evoke a different item score depending on the participant's proficiency level. Notwithstanding a participant's prevailing proficiency level, the item will discriminate between different levels of participant proficiencies (Ebel *et al.,* 1989). A positive value indicates that the item is good at differentiating between high ability and low ability.

The **Discr** refers to an item's ability to discriminate between those participants who scored high and those who scored low in the overall test, categorized into three main parts (positive, negative and zero discriminations). A positive **Discr** indicates that more participants in the high scoring group answered the item correctly than those in the low scoring group, while a negative **Discr** occurs when the case is reversed. Zero **Discr** is obtained when an equal number of participants in the high scoring group and the low scoring group answer the test item correctly. Table 5.1 shows the level of discriminations according to Ebel (1986) and Hetzel (1997).

Table 5.1: Discrimination Level

Index Range	**Discrimination Level**
0.19 and below	Poor item, should be eliminated or needs to be revised
0.20- 0.29	Marginal item, needs some revision
0.30-0.39	Reasonably good item but possibly for improvement
0.40 and above	Very good item

The formula to calculate the **Discr** is as follows:

$D_I = C_{UG} - C_{LG} /D$, where D_I = discrimination index value, C_{UG} = number of respondents opting for the correct answer in the upper group and C_{LG} = number of respondents opting for the correct answer in the lower group.

5.2.3. Point-biserial Correlation (PBis)

The Point-biserial Correlation (**PBis**) relates the scores that participants obtain on a given item to the total scores obtained when summing up their scores across the remaining items. A large positive value shows that participants with high scores in the overall test answered the item correctly, and participants with low scores in the overall test indicated the item incorrectly. **PBis** is the whole score of the test correlated with the individual item scores. This is a special case of the Pearson Product Moment Correlation, where one variable is binary (right vs. wrong), and the other is continuous (total raw test score). When participants who performed better in the test as a whole missed a particular item, this is indicated by a negative **PBis** on such an item, while participants who performed below average in the test overall responded to the same item correctly.

The equation for PBis = $$\frac{r_{pb} = \overline{X}_1 - \overline{X}_0\sqrt{p(1-p)}}{S_X}$$

$\overline{X}_1$	"Mean raw score of all examinees who got the item right
$\overline{X}_0$	Mean raw score of all examinees who got the item wrong
S_X	Standard deviation of the raw scores
p	Proportion of students who got the right answer" (Lowry, 2015)

The values of **Discr** and **PBis** should be greater than 0.2.

5.2.4. Difficulty level (PVal)

The Item Difficulty (**Pval**) (also called Item Facility) "value ranges between 0 and 1. It describes how easy an item is for the given sample of participants, with higher values indicating an easier test item. The value of 0 indicates that no participant responded correctly and a value of 1 indicates that all participants responded correctly" (Olugbara *et al*., 2014).

Table 5.2: Difficulty Level

Index Range	Difficulty Level
0.00 - 0.20	Very Difficult
0.21 - 0.40	Difficult
0.41 - 0.60	Average/Moderately Difficult
0.61 - 0.80	Easy
0.81 - 1.00	Very Easy

The formula to calculate the difficulty index is as follows:

$D_{F} =$ n/N, where $D_{F} =$ difficulty index, n= number of examinees selecting the correct item in the upper group and lower group and N= total number of examinees who took the test.

5.3. Results using IRT

Table 5.3 presents an extract of the results for the **Post-test responses** to facilitate the analysis and discussion of the results, while the full set of results is available in Appendix 1

Table 5.3: Extract from IRT Parameter Distractor Analysis for Post-Test responses

Item No	Options	Discr	PVal	PBis	A	b	c
ITEM 34 (Social Media)	No skill	0.02	**0.99**	0.26	1.52	-3.14	0.00
	Limited skill	0.14	**0.96**	0.44	1.43	-2.21	0.00
	Average skill	0.35	0.87	**0.57**	1.24	-1.49	0.00
	Good skill	**0.77**	0.67	**0.69**	1.46	-0.51	0.00
	Expert skill	0.52	0.20	**0.49**	1.15	1.11	0.00
ITEM 43 (Search engine to access government information)	No skill	0.06	**0.96**	0.14	1.13	-5.15	0.00
	Limited skill	0.47	**0.84**	0.62	1.23	-1.27	0.00
	Average skill	0.86	0.68	**0.70**	1.39	-0.56	0.00
	Good skill	**0.83**	0.33	**0.61**	1.31	0.55	0.00
	Expert skill	0.13	0.04	**0.30**	1.30	2.28	0.00

In Table 5.3 the Discr, PVal, PBis, a, b, and c are calculated for each skill level for each item. From the two items shown, Item 34 and Item 43, it can be seen that the Discr values range from 0.06 to 0.86. However, for both items, at Good Skill level the Discr is 0.77 and 0.83, respectively, which is much higher than 0.4. This shows that at these levels the items were good at discriminating between participants with poor ability and those with good ability. The PVal for both items at No Skill to Average Skill levels is close to 1, indicating that both items were easy for participants at these levels. The PBis values for the two items, ranging from 0.14 to 0.70, show that participants with high scores on the overall test answered the item correctly, and participants with low scores on the overall test indicated the item incorrectly, particularly for the skills levels of Average Skill to Expert Skill.

When the values for the a, b and c parameters are examined in Table 5.3, the values for a, which represents the relationship between a participant's performance on a specific item and the overall test performance of all the participants, are much higher than the required 0.4, indicating that this item discriminates well between participants with high ability and those with low ability. The values of the b-parameter, which indicates the difficulty level, show that the items were on average more easy than difficult. All the c-parameters are 0, indicating that no pseudo-guessing was detected.

The results for all items (Appendix 1) show that the discriminatory values (a), which are used to determine the Discr of all items were high, ranging from 0.36 (Item 25: Use word processors to create report: Expert Skill) to 1.87 (Item 34: Use social media to facilitate mobile interaction: Limited Skill). The Discr for most items is high, especially at the Average and Good Skill level, with the lowest at 0.02 (Item 36: Use RSS feeds: Expert Skill Skill) and the highest at 0.88 (Item 30: Use a government portal/web site for crop market prices: Good Skill).

In summary the results show that the CDWs' skills levels were towards the lower end of the spectrum, i.e., No Skill to Average Skill, while the ideal would be a skills level of Good to Expert for most of the items. The skills levels for most of the items were particularly weak, which can be seen when one compares the PVal of the combined Good Skill and Expert Skill to the combined values of No Skill to Average Skill.

5.4. Using IATA to analyse the responses

Microsoft Excel was used to capture each participant's response to each question. This data was used as input for IATA. Employing IATA software resulted in the screenshots in Figures 5.1 to 5.3, showing the results for Question 35, Excellent Skill as an example. The Discr, PBis, and PVal are shown, as well as the estimates of (IRT) parameters, parameters a, b and c, where a = slope parameters, b = the location parameters and c = the pseudo-guessing parameter.

The distracter is the term used for incorrect options in a multiple-choice type of test, while the correct answer represents the key. **Distractor analysis** is used to compare and determine errors arising from poor wording, confusing instructions, sampling errors and miss-keying or miscoding of responses. These are the effects to look for in distractor analysis:

Use	O	Discr	PVal	PBis	a	b	c
☑		0.78	0.74	0.70	1.52	-0.75	0.00
☑		0.69	0.38	0.50	0.90	0.47	0.00
☑		0.35	0.84	0.52	0.95	-1.45	0.00
☑		0.54	0.74	0.59	1.08	-0.85	0.00
☑		0.57	0.44	0.48	0.79	0.22	0.00
☑		0.31	0.76	0.30	0.63	-2.00	0.00
☑		0.54	0.67	0.48	0.63	-0.82	0.00
☑		0.77	0.47	0.57	0.91	0.13	0.00
☑		0.43	0.81	0.48	1.04	-1.40	0.00
☑		0.68	0.73	0.64	1.19	-0.80	0.00
☑		0.79	0.50	0.62	1.11	0.01	0.00
☑		0.61	0.76	0.58	0.99	-0.99	0.00
☑		0.82	0.62	0.67	1.27	-0.40	0.00
☑		0.43	0.21	0.39	0.71	1.41	0.00
☑		0.57	0.76	0.58	1.12	-0.98	0.00
☑		0.74	0.64	0.64	1.23	-0.46	0.00
☑		0.62	0.28	0.51	1.06	0.80	0.00
☑		0.37	0.81	0.45	0.97	-1.51	0.00
☑		0.72	0.66	0.64	1.19	-0.54	0.00
☑		0.67	0.41	0.53	0.98	0.31	0.00
☑		0.50	0.76	0.48	0.95	-1.17	0.00
☑		0.72	0.63	0.59	0.97	-0.49	0.00
☑		0.77	0.36	0.57	1.14	0.47	0.00
☑		0.63	0.77	0.66	1.24	-0.92	0.00
☑		0.82	0.61	0.71	1.54	-0.34	0.00
☑		0.58	0.30	0.47	0.87	0.81	0.00
☑		0.57	0.82	0.65	1.38	-1.10	0.00

Figure 5.1: Item Response for item Q35: Excellent Skill

1. The correct column option, in Figure 5.2 below the graph, denoted by the asterisk (*), should have a high percentage for the high skilled group, and successively lower percentages for the medium and low skilled groups. Item Q35: Excellent Skill satisfies this condition, with values of 86.8, 35.3, and 8.2 for the high, medium and low skilled groups, respectively.
2. In the low-skilled group, the percentage of participants choosing the correct option should be lower than the percentage of participants choosing any of the other options (Hogan, 2007; Zurawski, Gronlund & Linn, 1990). For example, Figure 5.2 shows Item 35 from the questionnaire with the options 0, 1, 2, 3 and 4. (See Appendix 1 items).

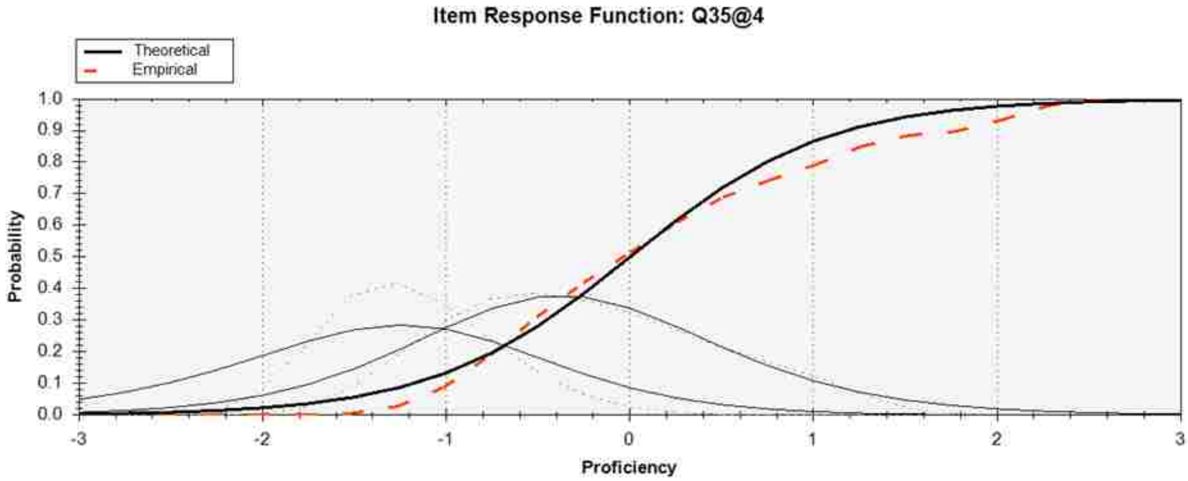

Figure 5.2: Item Response Function for Item 35 at Excellent Skill Level

3. Each of the columns corresponding to incorrect response values, i.e., columns 1, 2, and 3 in Figure 5.2, should have approximately equal percentages at each skill level, low, medium and overall compared to the other incorrect response values. Item Q35: Excellent Skill violates this pattern, because option 3 is endorsed by almost twice as many incorrect responses as either 1 or 2.
4. For the high-skilled group, the percentage choosing the correct option should be higher than the percentage choosing any of the other options. Item Q35 Excellent Skill option 4, satisfies this pattern: 86.8 is greater than the values for 1 (0.0), 2 (0.0), and 3 (11.3).
5. For all groups, the percentage of missing value codes (denoted by an X) should be close to 0. A substantial proportion of the respondents had missing responses (code 9), but the occurrence was greater in low performers than high performers, suggesting that the decision to treat the code as incorrect (rather than as omitted) was reasonable.
6. Missing response codes that are treated as omitted (denoted by OMIT) should have equal percentages of respondents at each skill level. This code was not used for these data.

Furthermore, the bottom of the table on the left in Figure 5.2 shows the different rows that were created automatically by IATA (Cartwright, 2013) for each of the item scores for each of the partial credit items. For rows that represent the scores of partial credit items (where the "Name" column contains the "@" symbol followed by an integer), the statistics are estimated as if each score were a single correct/incorrect item, where the correct answer is any score value greater than or equal to the selected score. IATA creates an additional set of statistical results for each partial credit score that is provided in the scoring key for an item. For example, if a partial credit item has a non-zero score of 1 and 2, the item facility for the score of 1 ("ItemName@1") would describe the proportion of students with item scores greater than or equal to 1, and the item facility for the score of 2 ("ItemName@2") would describe the proportion of students with a score of 2. In the distractor analysis table in Figure 5.2, note that Q35@4 uses codes of both 4 and 5 as keyed responses; for Q35@1, codes 1, 2, and 3 would be used as keyed responses. The item facilities are always larger for the lower scores of an item because they include all the students that were assigned higher scores. "The relative value of each response category across all items is treated as being the same, and the unit increases across the rating scale are given equal value" (Bond and Fox, 2007). For example, the results represented in Figure 5.2 highlight the results for Item Q35 with the score of 4 selected. For this item, the score of 1 (Q35@1) has a PVal of 0.47; the score 2 (Q35@2) has a PVal of 0.81; that of 3 (Q35@3) has a PVal of 0.73 and the score of 4 (Q35@4) has a PVal of 0.50.

5.4.1. Item Dimensionality

One of the test statistical assumptions of IRT, as well as a requirement for the valid interpretation of test results, is that performance on the test items represents a single interpretable construct or dimension. Ideally, a national achievement test of a construct such as e-skills ability or computer literacy should measure the single construct or dimension that it is designed to measure and should not measure other constructs or dimensions such as reading ability or English literacy. The purpose of the test dimensionality interface is to detect any violations of the assumptions that: 1) a single dominant dimension influences performance, and 2) the relationship between performance on pairs or groups of items can be explained by the dominant dimension. In most cases, the second assumption proceeds from the first, but for long tests (e.g., with more than 50 items), small groups of items may be locally dependent without having a noticeable effect on the overall test dimensionality. This assessment has more than 50 items. A loading factor is used to ensure a single dominant dimension.

The loading factor on the primary dimension for the item ranges from -1 to 1 and is the correlation between the performance on each item and the primary test dimension (the CDW's e-skill ability level). Figure 5.3 shows that Item 25: Average Skill (Option 2) has loadings of 0.57; the scored responses to this item have a correlation of 0.57 with the overall test score (per cent correct). There is no ideal value, but better items are indicated by loadings closer to 1. However, it is unreasonable to have a loading equal to 1.

The main result depicted in Figure 5.3 shows the screen plot for Item 25, and defines the proportion of variance explained by each potential dimension (eigenvalue). The dashed red line connecting the circle-shaped markers arranged from left to right illustrates the relative influence of each item's potential dimension (eigenvalue) on the overall test results, and the solid blue line connecting the box-shaped markers shows the relative influence of each potential dimension on the individual test items (squared loading). As the magnitude of the eigenvalues is less important than the pattern of the scree plot for the overall test, it should have a single point on the upper left of the chart (approximately 0.35, for example, in Figure 5.3), which connects to a near-horizontal straight line at the bottom of the chart that continues to be straight to the right side of the graph. This L-shaped pattern with only two distinct line segments suggests that a single common dimension is responsible for the test results. The greater the number of distinct line segments it takes to connect the top-left point to the near-horizontal line at the bottom, the more dimensions are likely to underlie test performance. If the overall scree plot does not indicate any problems, it is likely that the effects of any item-level multidimensionality or co-dependence will be negligible; except for five items (25@3, 31@4, 34@2, 36@4 and Q40@4) that violate this rule (See Appendix 2), all items are retained for subsequent analysis because the overall scree plot does not indicate any problems.

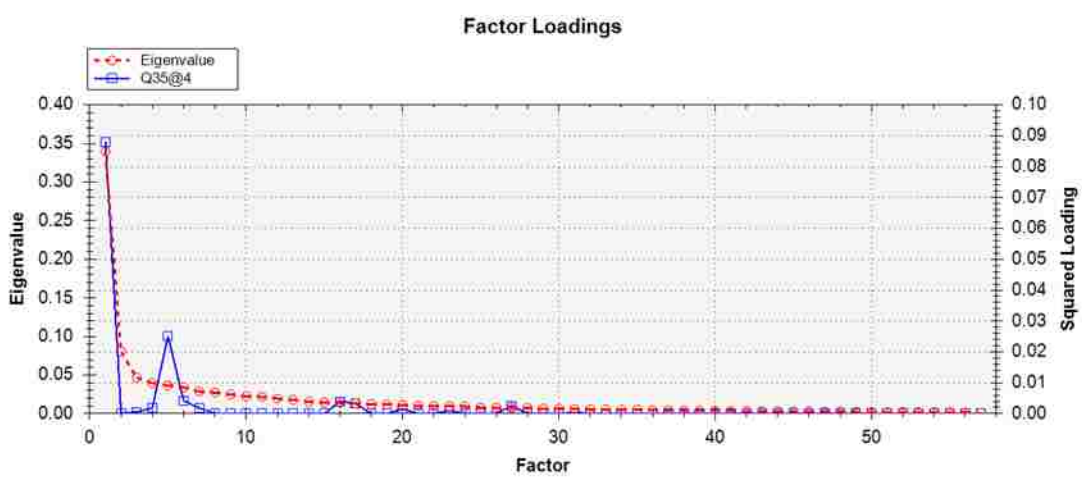

Figure 5.3: Loading Factor for Item 25 at Limited Skill Level

The graph in Figure 5.3 appears to be a sharp cliff with a right angle at the bottom. If there is a gradual slope, the test may be multidimensional. The loading column in Appendix 2 indicates how strongly each item is related to the major dimension of the test (See Appendix 2 for the complete item).

5.4.2. Comparing Pre- and Post-test results

Using the IATA software package to analyse the data for IRT parameters resulted in Table 5.4, which is an extract of the full table (See Appendix 1) when comparing the Pre-test and Post-test results.

Table 5.4: IRT Parameters for the Responses from Pre-Test and Post-Test

	Pre-Test							Post-Test					
ITEM	Discr	PVal	PBis	A	b	c	ITEM	Discr	PVal	PBis	a	b	C
Q25@1	0.00	1.00	NaN	0.46	-999.00	0.00	Q25@1	0.04	0.99	0.31	1.42	-2.83	0.00
Q25@4	0.29	0.09*	0.63	1.13	1.88	0.00	Q25@4	0.78	0.54*	0.63	1.24	-0.14	0.00
Q26@4	0.37	0.15	0.55	0.85	1.62	0.00	Q26@4	0.82	0.61	0.69	1.54	-0.34	0.00
Q28@4	0.12	0.03*	0.49	1.19	2.50	0.00	Q28@4	0.88	0.42*	0.64	1.41	0.25	0.00
Q29@4	0.38	0.13*	0.56	0.88	1.75	0.00	Q29@4	0.78	0.44*	0.63	1.36	0.19	0.00
Q30@3	0.53	0.17	0.68	1.07	1.29	0.00	Q30@3	0.69	0.74*	0.70	1.55	-0.76	0.00
Q30@4	0.22	0.06*	0.52	1.00	2.26	0.00	Q30@4	0.90	0.41*	0.67	1.66	0.25	0.00
Q33@3	0.47	0.16	0.63	0.98	1.46	0.00	Q33@3	0.65	0.81*	0.72	1.75	-1.01	0.00
Q33@4	0.16	0.05*	0.52	1.09	2.33	0.00	Q33@4	0.86	0.52*	0.68	1.59	-0.05	0.00
Q34@3	0.85	0.43	0.68	1.29	0.22	0.00	Q34@3	0.35	0.87*	0.57	1.26	-1.48	0.00
Q34@4	0.52	0.19*	0.64	0.98	1.28	0.00	Q34@4	0.78	0.67*	0.69	1.47	-0.51	0.00
Q38@4	0.14	0.04*	0.44	0.94	2.61	0.00	Q38@4	0.88	0.52*	0.68	1.40	-0.06	0.00

The complementary application of IRT provides a robust analysis of CDWs' e-skills levels. Table 5.4 shows some of the significant results. Q25@1 shows the results for Item 25 at No Skill level. For item Q25@4, based on the estimate IRT parameters given in Table 5.4, some improvement in CDWs' e-skills levels is evident. The Pre-test responses show that only 9% (PVal=0.09) of CDWs responded well to Item 25 (word processor) at Good Skill level; this improved significantly to 54% (PVal =0.54) in the Post-test. Other significant improvements (marked with *) from Pre-test to Post-test are the response to Item 26 ("to what extent can you use a document template to report poverty issues to an information manager?") where only 15% of the respondents (PVal =0.15) reported good skill; this improved to 61% (Pval =0.61). Another example is Item 30 ("to what extent can you use a search engine (search engine in a government portal or a website) to access crop market prices?"). In the Pre-test only 17% (PVal = 0.16) of the CDWs reported good skill; this improved to 41% in the Post-test (Pval = 0.41). As seen in Table 5.4, both the discrimination index (a) and difficulty level (b) also improved significantly in all the items from Pre-test to Post-test.

5.4.3. Pre-Test Performance Standards

In determining whether the instrument, in this case the self-reporting questionnaire, measures what is was supposed to measure, the probability value in Figure 5.4 indicates the probability of obtaining the same value for a model formulated between two hypotheses. The instrument measures what it is supposed to measure, being CDWs' ICT skills levels or is represented as 'neutral' (or 'null'). In line with the literature (Cartwright, 2013), the threshold of acceptable ICT skills is set to 67 in the software before running the data and the probability is less than the default threshold (traditionally 5% or 1%). However, the measured hypothesis can be accepted as valid and the neutral hypothesis is rejected. Furthermore, the performance standard result for this assessment is valid as the threshold is 1.43, with a mean of 1.14, and standard deviation of 0.79. However, the probability is less than threshold. (Fasasi and Heukelman, 2014)

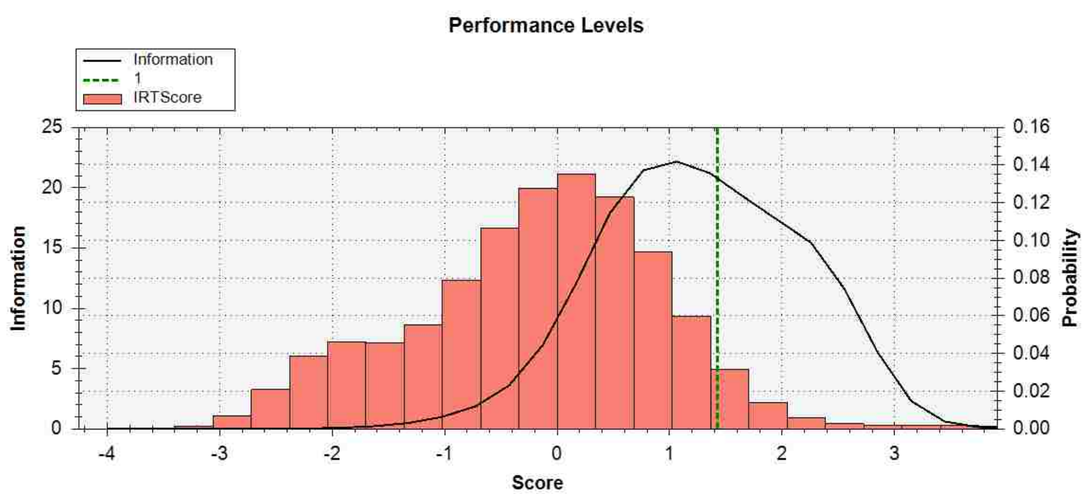

Figure 5.4: Performance level for Pre-Test assessment of CDWs' ICT skills levels

The response probability setting for the software is set to a default of 67 as is common practice to determine what tends to be statistically optimal at the item level. In general, considering the following thresholds as stated by Nuzzo (2014), if the correlation is significant at <0.01 level (2-tailed) then it is a very strong assumption against the neutral hypothesis, while if the correlation is significant at $0.01 < p < 0.05$ then it is a strong assumption against the neutral hypothesis. If the correlation is significant at $0.05 < p < 0.1$, there is a low assumption against the neutral hypothesis, while if the correlation is significant at p > 0.1, there is no assumption against the neutral hypothesis. This Pre-Test assessment result has a very strong assumption against the neutral hypothesis as the correlation is significant at the 0.01 level (**. 2-tailed) (Fasasi and Heukelman, 2014)

5.4.4. Post-Test Performance Standards

In the statistical analysis, the probability value in Figure 5.5 indicates the probability of obtaining the same value for a model formulated between two hypotheses, one of which is represented as 'neutral' (or 'null') while the other is subjected to hypothesis measuring" (Fasasi, Heukelman, 2014). In line with the literature as stated before, "the threshold is set to 67 in the software before running the data and the probability is less than the default threshold (traditionally 5% or 1%). However, the measured hypothesis can be accepted as valid and the neutral hypothesis is rejected. Furthermore, the performance standard result for this assessment is valid as the threshold is -0.15, with a mean of -0.53, and standard deviation is 0.74. However, the probability is less than threshold (Fasasi and Heukelman, 2014)

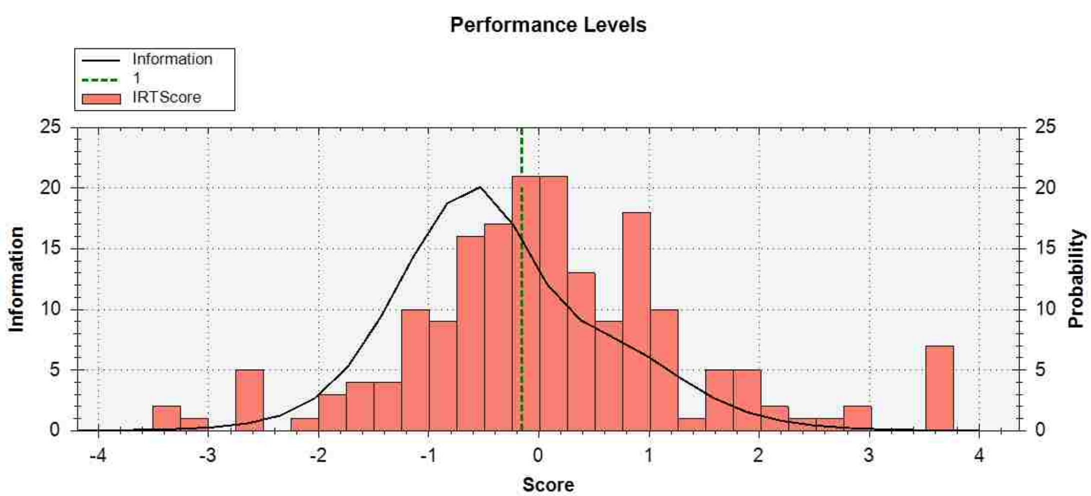

Figure 5.5: Performance level for Post-Test assessment of CDWs' ICT skills levels

The response probability setting is set to a default of 67 as it is common practice to determine what tends to be statistically optimal at the item level. In general, considering the following thresholds as stated by Nuzzo (2014), if the correlation is significant at <0.01 level (2-tailed), it is a very strong assumption against the neutral hypothesis, while if the correlation is significant at 0.01 < p < 0.05 then it is a strong assumption against the neutral hypothesis. If the correlation is significant at $0.05 < p < 0.1$, it is a low assumption against the neutral hypothesis while if the correlation is significant at $p > 0.1$, there is no assumption against the neutral hypothesis. This Post-Test assessment result has a very strong assumption against the neutral hypothesis as the correlation is significant at the 0.01 level (**. 2-tailed) (Fasasi and Heukelman, 2014)

5.5. Analysis using Descriptive Statistics

The sample for the Pre-Test assessment data, summarized in Table 5.5, had a total of 327 respondents with the range of 80.2% from a rural area, 16.1% from a semi-rural area and 3.7% from an urban area. Only 57.8% of the participants had completed grade 12, while 41.8% had post-grade 12 qualifications and less than 0.60% had N6 and NPDE certificates. However, 58.6% of the participants had formal training on how to use computer and 41.4% had not been introduced to a computer (Fasasi and Heukelman, 2014). The sample data for the Post-Test assessment had a total of 189 respondents.

Table 5.5: Characteristics of the sample from Fasasi and Heukelman (2014)

“Area	Rural : 80.2%	Semi-Rural: 16.1%	Urban: 3.7%	
Education Level	NQF 4: 57.8%	NQF 5: 41.8%	NQF 6: 0.6%	
Formal ICT Training	Yes: 58.6%	No: 41.4%		
Competence in ICT	High: 4.9%	Average: 48.4%	Low: 40.9%	None: 5.8%
Internet Access	Yes: 87.5%	No: 12.5%”		

5.5.1. Environmental Details of Community Development Workers

The following Tables 5.6 to 5.8 summarize the environmental results obtained from the participants using the self-reporting questionnaire.

Table 5.6: Computer devices owned by CDWs

Device	Response
Desktop	16%
Tablet	8%
Laptop	96%
Smartphone	75%
Other (specified)	6%

Since the provincial government supplied laptops and smartphones, the percentages for these devices are high. The issuing of smartphones for new CDWs was possibly slightly delayed, causing this percentage to be lower than that for laptops.

Table 5.7: Quality of Internet connection in CDWs' various areas from Olugbara et al. (2014)

"Quality of Internet connection	**Response**
Very fast	3%
Fast	9%
Workable	36%
Slow	20%
Very slow	13%
Very reliable(never drops connection)	1%
Mostly reliable	0%
Drops connection sometimes	5%
Regularly drops connection"	1%

It is noteworthy that 20% of participants regarded the Internet connection as slow, which could impact on their use of the Internet. This is an on-going problem in rural areas, where the infrastructure is sometimes inadequate.

Table 5.8: Frequency of CDWs' Internet usage from Olugbara et al., (2014)

"Frequency of Internet usage	**Response**
More than once per day	50%
Once per day	19%
Once per week	15%
Once per month	3%
Never"	3%

However as can be seen from Table 5.8, 50% of the participants indicated that they access the Internet more than once per day and the majority at least one per week.

5.5.2. Analysis of Work Requirements of Community Development Workers

Tables 5.9, 5.10 and 5.11 present the responses on CDWs' work requirements on a daily, weekly and monthly basis. This Pre-Test report was used to contextualise the learning material to suit the CDWs' work environments.

Table 5.9: Frequency of tasks performed by CDWs that require ICT

Task	**Frequency**			
	Daily	Weekly	Monthly	Don't
Write report	3.7%	10.6%	77.8%	7.9%
Email people	26.5%	32.9%	24.3%	16.1%
Provide information to individuals	55.2%	17.3%	12.8%	14.7%
Talk to group of people	30.5%	38.1%	16.5%	14.9%
Attend meetings	12.5%	60%	15.6%	11.9%
Phone people	67.4%	10.3%	9.8%	12.5%
Search for information	51.6%	21.3%	12.8%	14.3%
Provide forms for people to complete	13.1%	26.8%	38.4%	21.7%
Sms groups of people	35%	30.1%	19.3%	15.6%
Submit a budget or financial statement	7.6%	4.6%	32%	55.8%

Table 5.9 shows that the most frequent daily activities are providing information to individuals (55.2%) and phoning people (67.4%). Monthly reports are generated (77.8%), which also take time to produce.

Table 5.10: Percentage of CDWs who had used certain software applications

Application	**Response**
Word processor	62%
Presentation software	26%
Spreadsheet	28%
Email	85%
Management information system	8%
Other (specified)	11%
None	11%

Table 5.11: Smartphone applications used by CDWs

Application	**Response**
WhatsApp	92%
Facebook	60%
Twitter	15%
Blackberry (BBM)	86%
Google	73%
Other (specified)	11%
None	2%

Since the smartphone supplied by the employer was Blackberry, it is the most prevalent (86%) in Table 5.11.

The responses on CDWs' skills levels yielded the following results when analysed:

Table 5.12: Mean and standard deviation for each item

ITEMS	PRE-TEST		POST-TEST	
	Mean	Std. Deviation	Mean	Std. Deviation
ITEM 25 Use word processors to create report	1.98	1.062	3.45	1.1595
ITEM 26 Use document template	2.30	1.052	3.60	1.1238
ITEM 27 Use software to present information	1.70	1.008	3.42	1.2076
ITEM 28 Use software to create poster	1.57	.880	3.30	1.1747
ITEM 29 Use search engine in a government portal/website crop management	1.88	1.104	3.34	1.2131
ITEM 30 Use search engine in a government portal/web site crop market prices	1.60	.925	3.28	1.3490
ITEM 31 Use search engine for supply chain tender	1.43	.788	3.21	1.2538
ITEM 32 Use search engine to find funding	1.77	.963	3.25	1.2101
ITEM 33 Use spreadsheet to analyse data	1.59	.888	3.40	1.1702
ITEM 34 Use social media to facilitate mobile interaction	2.34	1.142	3.74	1.0726
ITEM 35 Use government website to download forms	2.04	1.104	3.63	1.0571
ITEM 36 Use RSS feeds	1.43	.811	3.12	1.4685
ITEM 37 Synchronize calendars	1.54	.899	3.17	1.2260
ITEM 38 Use electronic media to set up meetings	1.56	.914	3.40	1.2231
ITEM 39 Set up groups on email accounts	1.51	.828	3.43	1.2722
ITEM 40 Use spreadsheet to set up a budget	1.31	.661	3.21	1.2984
ITEM 41 Capture associated data in structured format	1.54	.842	3.21	1.1475
ITEM 42 Use social media to create networking collaboration	1.53	.882	3.30	1.2330
ITEM 43 Use search engine to access government information	2.00	1.140	3.18	1.5606

Table 5.12 shows the mean and standard deviation for each e-skills domain measured. The mean scores for the pre-test data vary from the lowest (1.31) for Item Q40 to the highest (2.34) for Item 34, meaning that the CDWs generally responded below the average score of 3. This result reflects generally low e-skills levels. In table 5.12, the mean scores for the Post-Test data vary from the lowest value of 3.12 (Q36) to the highest value of 3.63 (Q34). This result means that CDWs generally responded to each item above the average score of 3 after the training intervention. (Fasasi and Heukelman, 2014)

5.5.3. Pre-Test Analysis Results for CDWs' Self-Assessment of ICT Skills

Table 5.13 shows the "Pre-Test analysis results for the CDWs' Self-Assessment of their ICT Skills. Item 34, "To what extent can you use social media (sms, email, twitter) to facilitate mobile interaction between community members and government representatives?" produced the highest results in the Expert Skill, Good Skill and Average Skill categories with values of 2.4%, 16.2% and 24.2%, respectively, indicating that, in the Pre-Test Assessment, the majority of the participants had limited or no skills in the rest of the items. Item 32, "To what extent can you use a search engine (search engine in a government portal/website) to find funding opportunities, donors and development agencies?" has the highest result in the Limited Skill category, with a value of 29.2%; indicating that 95 participants had limited skills in using search engines to find opportunities, donors and development agencies. Item 40, "To what extent can you use an electronic spreadsheet to set up a financial budget?" has the highest result in the NO SKILL category with a value of 78%, indicating that most of the participants had no knowledge or skills in using an electronic spreadsheet to set up a financial budget".

Table 5.13: Pre-Test Response Frequency of CDWs on ICT Skills Performance Evaluation

Item Description	No Skill	Limited Skill	Average Skill	Good Skill	Expert Skill
ITEM 25 Use word processors to create report	47.7	16.2	27.5	8.0	0.6
ITEM 26 Use document template	29.7	25.4	30.0	15.0	0.0
ITEM 27 Use software to present information	60.9	18.0	11.6	9.5	0.0
ITEM 28 Use software to create poster	66.1	14.4	16.2	3.4	0.0
ITEM 29 Use search engine in a government portal/website crop management	52.6	20.2	14.4	11.9	0.9
ITEM 30	64.2	18.3	11.3	5.8	0.3

Use search engine in a government portal/web site crop market prices					
ITEM 31 Use search engine for supply chain tender	70.6	19.6	5.8	3.7	0.3
ITEM 32 Use search engine to find funding	51.4	29.1	11.6	7.3	0.6
ITEM 33 Use spreadsheet to analyse data	62.1	22.3	10.7	4.3	0.6
ITEM 34 Use social media to facilitate mobile interaction	30.3	26.9	24.2	16.2	2.4
ITEM 35 Use government website to download forms	44.0	21.7	22.3	10.4	1.5
ITEM 36 Use RSS feeds	72.5	16.2	7.6	3.1	0.6
ITEM 37 Synchronize calendars	67.9	16.8	9.5	5.5	0.3
ITEM 38 Use electronic media to set up meetings	67.6	13.5	14.7	3.7	0.6
ITEM 39 Set up groups on email accounts	67.9	16.5	12.5	3.1	0.0
ITEM 40 Use spreadsheet to set up a budget	78	14.1	6.4	1.5	0.0
ITEM 41 Capture associated data in structured format	65.1	19.3	11.9	3.7	0.0
ITEM 42 Use social media to create networking collaboration	67.0	19.3	8.0	5.5	0.3
ITEM 43 Use search engine to access government information	47.4	20.5	19.0	11.0	2.1

In Figure 5.6, which is a graphical representation of Table 5.13, the column height shows frequency - the number of examinees in an overall item score grouping. Each bar represents a range of scores, and the height of each bar represents the proportion of examinees with scores at that range.

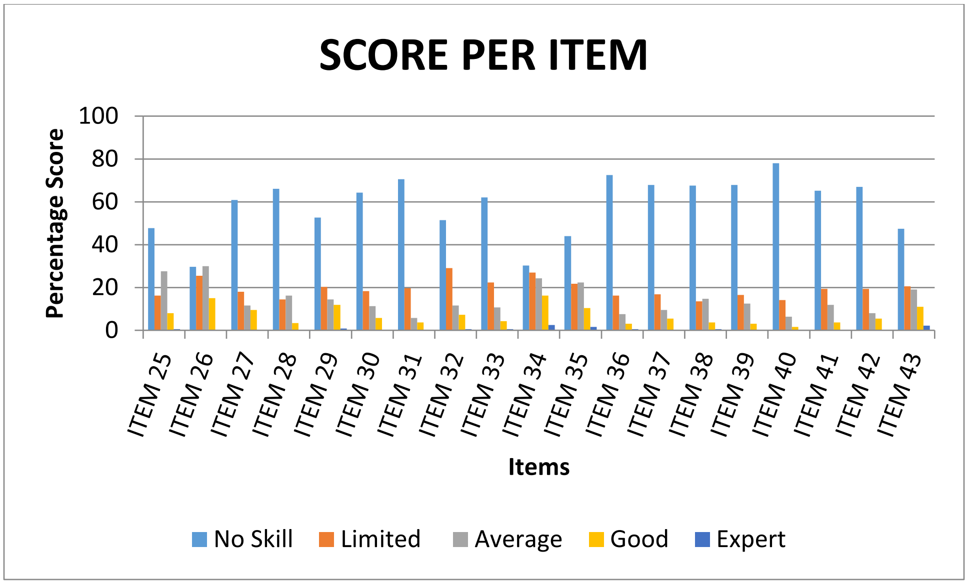

Figure 5.6: Graphical representation of Table 5.13

In the assessment before the training commenced, it is noticeable that the balance of answers lie within the No Skill range (between 60% and 80%) and that Average Skill, Good Skill and Expert Skill are far less. If however, one looks at the percentages involved, it is also very clear that Good Skill falls mostly at 0-0.5% or below, which shows there is a strong need to up skill the CDWs.

5.5.4. Post-Test Analysis Results for CDWs' Self-Assessment of ICT Skills

Table 5.14 shows the Post-Test analysis results for CDWs' Self-Assessment of their ICT Skills. Item 36, "To what extent can you use a Really Simple Syndication (RSS) feeds reader to collect information?" produced the highest result in the NO SKILL category with a value of 13.8%, indicating that less than 13.8% of the participants did not increase their knowledge or have no skills in the rest of the item. It also produced the lowest result in the GOOD SKILL category with a value of 20.6. Table 5.14 also shows that Item 35, "To what extent can you use a government portal/website to access and download government agency related information and forms?" produced the lowest result in the LIMITED SKILL category with a value of 7.9%. Item 34, "To what extent can you use social media (sms, email, twitter) to facilitate mobile interaction between community members and government representatives?" produced the lowest result in the AVERAGE SKILL category with a value of 20.6%, while item 32, "To what extent can you use a search engine (search engine in a government portal/website) to find funding opportunities, donors and development agencies?” produced the lowest result in the EXPERT SKILL category with a value of 5.8%”.

Table 5.14: Post-Test Response Frequency of CDWs on ICT Skills Performance Evaluation

Item Description	No Skill	Limited Skill	Average Skill	Good Skill	Expert Skill
ITEM 25 Use word processors to create report	5.8	12.7	25.9	46.0	8.5
ITEM 26 Use document template	4.8	9.5	23.3	50.3	11.1
ITEM 27 Use software to present information	6.3	10.1	33.9	40.7	7.4
ITEM 28 Use software to create poster	6.9	13.2	37.0	33.3	8.5
ITEM 29 Use search engine in a government portal/website crop management	7.9	11.1	36.0	32.8	11.1
ITEM 30 Use search engine in a government portal/web site crop market prices	9.0	14.8	32.8	34.4	6.9
ITEM 31 Use search engine for supply chain tender	10.1	14.8	33.3	31.7	9.0
ITEM 32 Use search engine to find funding	11.1	8.5	36.0	37.6	**5.8**
ITEM 33 Use spreadsheet to analyse data	7.4	10.6	29.1	44.4	7.4
ITEM 34 Use social media to facilitate mobile interaction	3.7	8.5	**20.6**	46.6	20.1
ITEM 35 Use government website to download forms	4.8	**7.9**	23.3	49.7	13.8
ITEM 36 Use RSS feeds	**13.8**	13.2	41.8	**20.6**	7.9
ITEM 37 Synchronize calendars	12.2	12.2	36.0	28.0	11.1
ITEM 38 Use electronic media to set up meetings	6.9	15.3	24.9	41.3	10.6
ITEM 39 Set up groups on email accounts	8.5	12.2	27.5	36.0	14.8
ITEM 40 Use spreadsheet to set up a budget	11.1	15.3	31.7	29.6	11.1
ITEM 41 Capture associated data in structured format	9.0	13.8	35.4	32.8	8.5
ITEM 42 Use social media to create networking collaboration	7.9	14.8	32.3	33.3	10.6
ITEM 43 Use search engine to access government information	12.7	15.9	34.9	28.6	4.2

5.5.5. Post-Test Scale Review Per Cent Score

In Figure 5.7 the column height shows frequency: the percentage of examinees who assessed their skills level for each of the items.

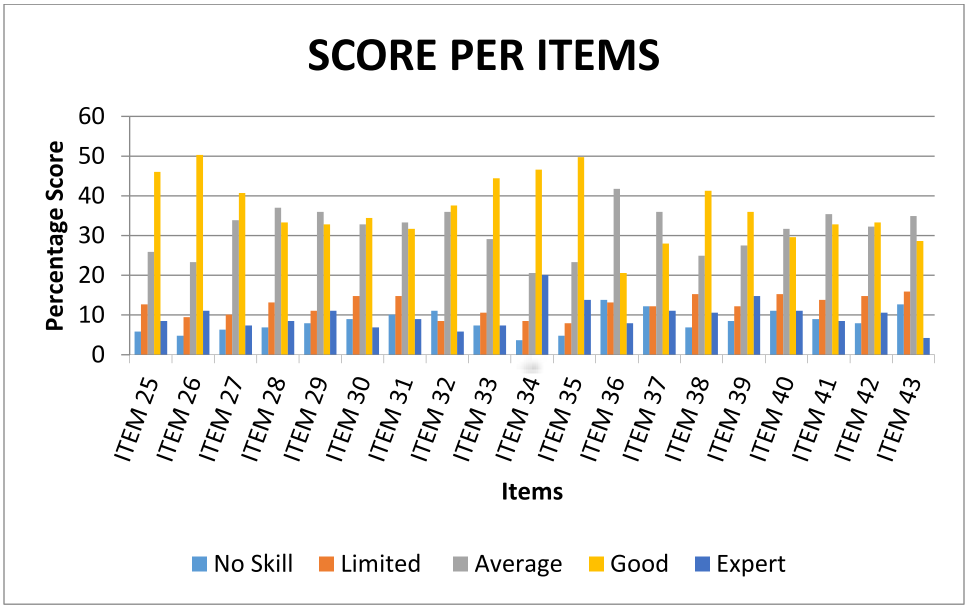

Figure 5.7: Graphical representation of Table 5.14

Approximately 50% of the responses fall within the Average to Good Skill range and there are far fewer in the No Skill, Limited Skill and Expert Skill categories. This is a significant improvement from the Pre-assessment, where Average to Good Skill comprised significantly fewer responses.

5.6. Summary of the Study and Findings

In the Pre-assessment for all participants (N=327), "the average score was 23.09%, with standard deviation of 21.86 and reliability of 0.95. The Post-assessment score for all participants (all those who participated in the e-skills training program) (N=189) yielded an average score of 62.43% with standard deviation of 24.88 and reliability of 0.94 (Fasasi and Heukelman, 2014)

Furthermore, to answer the research question on the level of skills the CDWs acquired from the e-SI training, the Pre-Test and Post-Test per cent scores were compared in order to determine if there was substantial variance (positive or negative). The average class per cent score for the Pre-Test was 23.09% while the average class per cent score for Post-Test was 62.43%, yielding a % variance of +39.34. This % of variation difference is positive as well as statistically significant. When a correlation analysis was performed, the Pre- and Post-assessment were significantly correlated at the 0.01 level (p=.01); this indicates that the assessment measures yielded identical results. Furthermore, the T-test produced a correlational significance at .001 level (p<.001**) (See Appendix 2) for the whole assessment. The difference between the Pre-Test assessment average score and the Post-Test assessment average score was statistically significant. The T-test assesses whether the mean (average) of different tests are statistically different from each other.

It was also important to verify whether the average scores 'increase or decrease' in class per cent score for the whole assessment. As stated earlier, the average score increased with the total point of +39.34% in the whole per cent score from the whole test. In answering the question of what percentage of the class showed progress in terms of a significant increase in class per cent score, it is observed that the percentage of the class with at least a 10% increase in class per cent score is more than 90%, indicating a 10% increment and above in class per cent score, ranging from 10.48% to 26.66%. More specifically, the frequency of 84% of the participants from the Pre-Test assessment scores is highest at 5%, whereas the frequency of approximately 33% ranges between 60% and 70% in the Post-Test assessment.

"Several data-driven studies have shown that there is always an improvement between the Pre-Test assessment and the Post-Test assessment (Winter, 1977). The current study's findings show that there was a significant improvement in the students' performance in the Post-Test assessment compared to the Pre-Test assessment. This can be attributed to efficient planning during the training program. As noted in Chapter 2, Pre-Test assessment involves testing the participants before the commencement of the training program while Post-Test assessment involves testing them at the end of the program. This enables participants' knowledge, attitudes, or behaviours to be evaluated" (Fasasi and Heukelman, 2014)

It can therefore be concluded that this ICT training intervention not only helped the students understand and gain better ICT skills and knowledge, it also promoted a better understanding of how to measure the quality of the education output.

5.7. Limitations of the Study

The limitation of this study is the relatively small sample size of Post-assessment used to investigate the impact of the longitudinal assessment model at the end of the training program. Furthermore, the assessment was only carried out at a single-stage (T_0 to T_1) which is from one point to another. As noted earlier, one weakness of the single-stage approach is its inability to distinguish between an individual that maintains Pre-teaching knowledge during the course of the session from another individual who forfeits knowledge and then relearns it during the learning session or term. This renders authentication limited as there is merely improvement from the assessment of T_0 to $T_{1.}$ Thus, pedagogy should be designed to address and improve the items with low knowledge ability in T_0 by the next assessment of T_1. If the renormalized change continues in more than the two-stage (e.g. $T_{1\ to}T_2$ and T_3), it will improve the knowledge gained as an alternative pedagogy has to be designed to redress the situation (Fasasi and Heukelman, 2014)

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

This chapter further interprets the results presented in Chapter 5 to draw conclusions and make recommendations for further interventions as well as possible areas for further research.

6.1. Introduction

This study aimed to develop a multi-stage assessment model to measure the e-skills of CDWs who participated in the National e-Skills Plan of Action training program in South Africa as well as describe its implementation and measure its impact. The research questions were as follows:

- Which ICT skills are CDWs required to use in their work environment to meet their Key Performance Indicators (KPIs)?
- Which (ICT) skills require improvement to enhance CDWs' productivity?
- How can the impact of the training be measured in terms of upgrading the ICT skills to improved KPI's for CDWs?

Since action research involves the purposive redesign of studies while they are in progress, new questions can be developed and the original questions are refined through each assessment. The purpose of research is to answer the questions posed until the problem is solved to the satisfaction of the researcher (Greenwood & Levin, 1998).

This chapter presents a brief overview of the findings of the study and evaluates their efficacy. The findings that resulted from the two assessments are summarized as answers to the research questions and provide the basis for the multi-stage assessment model.

6.1.1. Which ICT skills are CDWs required to use in their work environment to meet their KPIs?

The CDWs' work environment was used to contextualize the framework using the European e-Competence Framework for ICT Users - Part 1 (CEN, 2013) to determine which ICT skills could promote CDWs' efficiency.

The result of matching the e-Competence Framework to the ICT skills which could enhance the CDWs' KPIs were captured in the syllabus used to teach the CDWs. Basic computer literacy skills were combined with information and mobile literacy to form an integrated syllabus to achieve e-Literacy, as described in Chapter 1.

Applications using word processing, spreadsheets and presentations were combined with Internet searching skills and social media, which was mainly done using participants' mobile phones, to achieve a combination which would be useful to the CDWs. Contributions by employers and stakeholders were used to refine the syllabus.

The informal feedback from the participants was positive and their enthusiasm for the training showed that they found the contents useful and appealing. Further enhancements should be considered, based on more formal feedback from both participants and employers. The changing nature of ICT would also require regular revision of the contents of the training.

The use of an LMS to facilitate the training contributed to the development of ICT skills and also provided a means of continued interaction with the learning material.

6.1.2. Which (ICT) skills require improvement to enhance CDWs' productivity?

To answer this question, the results from Chapter 5, section 5.4.3 on the Pre-Test self-analysis of the CDWs' ICT skills are used. It is clear from Figure 5.6 that skills levels in the categories of Very Good and Expert Skill are extremely low and the No Skill category is far higher than the combined levels for Limited, Average, Good and Expert Skill. In summary, this means that all the ICT skills required for the CDWs to meet their KPIs require upgrading.

6.1.3. How can the impact of this training be measured?

Both IRT and CTT were used to analyse the results and provided a means to measure the impact of the training offered to CDWs. The use of IRT helped to ensure that the questions asked could be proven to be both good and able to discriminate between the participants' different skills categories. All the items had an acceptable discriminatory index, meaning that they could distinguish those participants who had a high level of skill before the training intervention from those with a low skill level. This also allowed the responses to be analysed in much more depth. The use of CTT enabled overall conclusions to be reached and confirmed the more in-depth conclusions drawn using IRT.

Both IRT and CTT confirmed that the training intervention raised the skills levels achieved from predominantly No Skill and Average Skill to Average and Good Skill, as can be seen in Figure 5.7, which presents the Post-Test results. This leads to the conclusion that the training intervention yielded positive results. Both the IRT and CTT results confirmed this.

The study also sought to determine which ICT skills CDWs require in their work environment to meet their KPIs. From the data collected it appears that word processing, which is required for reporting, is an essential skill. Since participants attend meetings on a weekly basis, word processing could also be used to capture minutes or main focus points. Searching for information is also a core activity; therefore, using a search engine and being able to download information from websites, be they government or other websites, would be an essential skill. Once the information has been located, it has to be presented to people and presentation software could play a significant role in this regard.

Since social media has become a pervasive technology, using such media to send meeting alerts, disseminate information and promote general interactivity should be regarded as an essential skill, which was addressed within the course, as described in Chapter 4, Table 4.1 and Module 8 of the training.

In terms of ICT skills that require improvement, the data revealed that a large percentage of participants do not rate their skill level for many of the ICT skills they are required to use in their work environments as Good or Expert. They identified the need for interventions to improve those skills and for them to gain confidence in using ICT skills to promote productivity.

The KZN provincial government has recognized that ICT can play a significant role in facilitating interaction between the government and communities. However, ICT training was not included in the initial basic training for CDWs. Based on this study’s findings, it is recommended that ICT training should be introduced in the existing CDW training program. This would ensure that CDWs are able to effectively retrieve, present and disseminate information to different stakeholders and address the existing gap. Furthermore, this will promote flexible and effective community development services. Another recommendation would be to offer ICT courses to current CDWs on a regular basis to address inadequate skills levels; however, if skills levels are to be maintained, participants would need to embrace independent, life-long learning. ICT embraces innovation and its changing landscape requires self-skilling while using the technology.

6.2. Final Conclusions

Based on the findings, and considering the broader issues, final conclusions that expand on the significance of the findings are presented. Recommendations are made for:

i. the Multi-Stage Assessment Model;

ii. an education improvement strategy; and

iii. further research.

6.2.1. Developing the Multi-Stage Assessment Model

Only two assessments were conducted for this study; a Pre-assessment and a Post-assessment. The value of the Pre-assessment lies in determining the skills levels of participants before the intervention. The use of IRT ensured that a true skills level could be obtained for the participants. This was very important because the pervasiveness of ICT in society enables community members to gain ICT skills informally. The Pre-assessment confirmed that some skills were present, and it was important to 'quantify' these skills.

Consultations with the study participants and other stakeholders through each assessment in the development of the Multi-Stage Assessment Model contributed to high levels of engagement by participants. This consultative process enabled both instructors and participants to identify the key elements of an assessment and subsequently improved standards. Encouraging the participants to assess their own ability levels, as done with the self-assessment questionnaire, improves pedagogic systems and enables instructors to make recommendations on the pedagogic system to adopt in future in order to significantly impact the change process. One of the modules, Google Maps Engine was developed after the start of the training based on discussions with participants about their work environments.

Testing the Multi-Stage Assessment through the pilot phase within the KZN cohort of CDWs was an important part of the development of the model. This ensured that the processes were well developed prior to national rollout (yet to be implemented) in that the problems associated with the pilot phase were resolved. In turn, this will lead to higher levels of satisfaction among both the instructors and participants when the system is rolled out for implementation at national level.

Post-assessment of the impact of the training on the CDWs' ICT skills levels allowed conclusions to be drawn on the impact of the training, irrespective of the pre-training skills levels. The IRT enabled this impact to be clearly 'quantified' and demonstrated that the training was effective.

6.3. Recommendations

In line with these conclusions, recommendations are made as follows:

i. the Multi-Stage Assessment Model as a national education improvement mechanism; and

ii. further research.

6.3.1. Recommendations in Relation to the Multi-Stage Assessment Model

The Multi-Stage Assessment Model should be implemented as the key improvement mechanism for the National E-skills Plan of Action (e-skills training program) and is also recommended for most educational sectors in South Africa. It should be redeveloped to include updated quality standards, and internal evaluation and planning processes. This redevelopment should take cognisance of the pervasiveness of ICT and the imminent adoption of a new operational time frame in order to repeat the test many times in the National E-skills Plan of Action Training program. The implementation process of NeSPA (NeSPA, 2013) should be simplified to avoid the detailed level of review that currently exists and reduce the emphasis on the production of the plan as a document. Provincial interventions should be evaluated critically and adjustments to the rollout at national level should be made, based on the provincial evaluations, as with this study. Planning of pedagogic actions should result from self-evaluation rather than the planning process. Training programs should engage in participant evaluation at more intervals. Detailed pedagogy action plans should also result from improved evaluations. The continuation of the facilitator-led approach where the process and process outcomes are ensured as opposed to the achievement of the task alone is also recommended (Fasasi and Heukelman, 2014)

6.3.2. Recommendations for Further Research

It is recommended that studies be conducted to further examine the impact of the Assessment Model and to assist its redevelopment and application in other settings. The specific recommendations for further research are as follows:

i. A large-scale evaluation of the impact of the Assessment Model on training programs should be conducted involving a larger sample. This should consider the limitations of the current study and should correct for researcher bias.

ii. In order to develop the Assessment Model to the next level, further research should be carried out to establish how outcomes for learners could be measured, including soft outcomes.

iii. The redevelopment of the Assessment Model should follow a similar action research process as was used in its original development. The redevelopment should involve the participation of instructors through each assessment stage and the redeveloped system should be piloted as part of the action research process.

iv. Research should be conducted on the impact of the inspection process on the training program and the possible usefulness of including self-evaluation as one of the criteria for inspection.

By way of final comment, these recommendations would greatly enhance quality education outcomes in skills training programs and the National E-skills Plan of Action program in South Africa (NeSPA, 2013) and have the potential to impact positively on other areas of education provision.

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APPENDIX 1
ITEM ANALYSIS RESULT FOR PRE-TEST

	Pre-Test							Post-Test					
ITEM	Discr	PVal	PBis	a	b	c	ITEM	Discr	PVal	PBis	a	b	c
Q25@1	0.00	1.00	NaN	0.46	-999.00	0.00	Q25@1	0.04	0.99	0.32	1.43	-2.83	0.00
Q25@2	0.79	0.52	0.54	1.01	-0.08	0.00	Q25@2	0.25	0.93	0.58	1.62	-1.82	0.00
Q25@3	0.69	0.36	0.55	0.78	0.57	0.00	Q25@3	0.49	0.80	0.59	1.12	-1.15	0.00
Q25@4	0.29	0.09	0.63	1.13	1.88	0.00	Q25@4	0.79	0.54	0.63	1.24	-0.14	0.00
Q25@5	0.02	0.01	0.06	0.36	8.69	0.00	Q25@5	0.21	0.08	0.34	1.08	1.92	0.00
Q26@1	0.00	1.00	NaN	0.24	-999.00	0.00	Q26@1	0.04	0.99	0.32	1.58	-2.83	0.00
Q26@2	0.73	0.70	0.48	1.41	-0.65	0.00	Q26@2	0.22	0.94	0.56	1.69	-1.92	0.00
Q26@3	0.80	0.45	0.59	0.93	0.18	0.00	Q26@3	0.49	0.85	0.69	1.66	-1.20	0.00
Q26@4	0.37	0.15	0.55	0.85	1.62	0.00	Q26@4	0.82	0.61	0.69	1.56	-0.33	0.00
Q26@5	0.00	0.00	0.00	-1.00	-999.00	0.00	Q26@5	0.25	0.11	0.34	0.87	1.89	0.00
Q27@1	0.00	1.00	NaN	0.24	-999.00	0.00	Q27@1	0.06	0.98	0.34	1.49	-2.66	0.00
Q27@2	0.80	0.39	0.64	1.18	0.36	0.00	Q27@2	0.29	0.92	0.60	1.63	-1.72	0.00
Q27@3	0.59	0.21	0.68	1.06	1.11	0.00	Q27@3	0.59	0.82	0.68	1.54	-1.10	0.00
Q27@4	0.32	0.09	0.54	0.94	1.96	0.00	Q27@4	0.85	0.48	0.64	1.36	0.06	0.00
Q27@5	0.00	0.00	0.00	-1.00	-999.00	0.00	Q27@5	0.21	0.07	0.35	1.14	1.98	0.00
Q28@1	0.00	1.00	NaN	0.31	-999.00	0.00	Q28@1	0.04	0.99	0.32	1.62	-2.83	0.00
Q28@2	0.82	0.34	0.72	1.27	0.52	0.00	Q28@2	0.29	0.92	0.58	1.58	-1.73	0.00
Q28@3	0.61	0.20	0.68	1.07	1.18	0.00	Q28@3	0.71	0.79	0.74	1.79	-0.91	0.00
Q28@4	0.12	0.03	0.49	1.19	2.50	0.00	Q28@4	0.88	0.42	0.64	1.37	0.25	0.00
Q28@5	0.00	0.00	0.00	-1.00	-999.00	0.00	Q28@5	0.27	0.08	0.39	1.25	1.81	0.00
Q29@1	0.00	1.00	NaN	0.72	-999.00	0.00	Q29@1	0.04	0.99	0.32	1.61	-2.83	0.00
Q29@2	0.93	0.47	0.69	1.58	0.07	0.00	Q29@2	0.33	0.91	0.64	1.78	-1.59	0.00
Q29@3	0.72	0.27	0.70	1.13	0.81	0.00	Q29@3	0.61	0.80	0.70	1.60	-0.99	0.00
Q29@4	0.38	0.13	0.56	0.88	1.75	0.00	Q29@4	0.79	0.44	0.63	1.32	0.19	0.00
Q29@5	0.03	0.01	0.23	1.03	3.52	0.00	Q29@5	0.33	0.11	0.43	1.26	1.59	0.00
Q30@1	0.00	1.00	NaN	0.73	-999.00	0.00	Q30@1	0.08	0.98	0.35	1.56	-2.59	0.00
Q30@2	0.79	0.36	0.67	1.22	0.46	0.00	Q30@2	0.39	0.89	0.65	1.61	-1.47	0.00
Q30@3	0.53	0.17	0.68	1.07	1.29	0.00	Q30@3	0.69	0.74	0.70	1.56	-0.76	0.00
Q30@4	0.22	0.06	0.52	1.00	2.26	0.00	Q30@4	0.88	0.41	0.66	1.61	0.25	0.00
Q30@5	0.01	0.00	0.19	1.37	3.62	0.00	Q30@5	0.25	0.07	0.40	1.50	1.86	0.00
Q31@1	0.00	1.00	NaN	0.69	-999.00	0.00	Q31@1	0.04	0.99	0.32	1.59	-2.83	0.00
Q31@2	0.72	0.29	0.65	1.06	0.74	0.00	Q31@2	0.39	0.89	0.65	1.68	-1.45	0.00
Q31@3	0.34	0.10	0.61	1.05	1.83	0.00	Q31@3	0.73	0.74	0.70	1.47	-0.77	0.00
Q31@4	0.14	0.04	0.44	0.97	2.63	0.00	Q31@4	0.75	0.41	0.61	1.30	0.29	0.00
Q31@5	0.01	0.00	0.19	1.37	3.62	0.00	Q31@5	0.31	0.09	0.42	1.39	1.70	0.00
Q32@1	0.00	1.00	NaN	0.69	-999.00	0.00	Q32@1	0.04	0.99	0.32	1.65	-2.83	0.00
Q32@2	0.93	0.49	0.67	1.56	0.04	0.00	Q32@2	0.43	0.88	0.69	1.74	-1.37	0.00
Q32@3	0.61	0.20	0.70	1.10	1.17	0.00	Q32@3	0.73	0.79	0.76	1.94	-0.91	0.00
Q32@4	0.25	0.08	0.51	0.89	2.17	0.00	Q32@4	0.85	0.43	0.65	1.40	0.20	0.00
Q32@5	0.02	0.01	0.18	0.90	4.07	0.00	Q32@5	0.17	0.06	0.31	1.06	2.23	0.00
Q33@1	0.00	1.00	NaN	0.62	-999.00	0.00	Q33@1	0.04	0.99	0.32	1.63	-2.83	0.00
Q33@2	0.67	0.38	0.52	0.81	0.48	0.00	Q33@2	0.31	0.92	0.64	1.79	-1.63	0.00

Q33@3	0.47	0.16	0.63	0.98	1.46	0.00	Q33@3	0.65	0.81	0.72	1.77	-1.00	0.00
Q33@4	0.16	0.05	0.52	1.09	2.33	0.00	Q33@4	0.86	0.52	0.68	1.57	-0.05	0.00
Q33@5	0.02	0.01	0.24	1.24	3.43	0.00	Q33@5	0.23	0.07	0.31	0.91	2.20	0.00
Q34@1	0.00	1.00	NaN	0.85	-999.00	0.00	Q34@1	0.02	0.99	0.26	1.52	-3.14	0.00
Q34@2	0.70	0.70	0.50	1.87	-0.57	0.00	Q34@2	0.14	0.96	0.44	1.43	-2.21	0.00
Q34@3	0.85	0.43	0.68	1.29	0.22	0.00	Q34@3	0.35	0.87	0.57	1.24	-1.49	0.00
Q34@4	0.52	0.19	0.64	0.98	1.28	0.00	Q34@4	0.77	0.67	0.69	1.46	-0.51	0.00
Q34@5	0.09	0.02	0.39	1.09	2.80	0.00	Q34@5	0.52	0.20	0.49	1.15	1.11	0.00
Q35@1	0.00	1.00	NaN	0.76	-999.00	0.00	Q35@1	0.02	0.99	0.26	1.63	-3.14	0.00
Q35@2	0.85	0.56	0.62	1.42	-0.18	0.00	Q35@2	0.20	0.95	0.54	1.59	-2.01	0.00
Q35@3	0.87	0.34	0.74	1.26	0.51	0.00	Q35@3	0.49	0.87	0.69	1.64	-1.33	0.00
Q35@4	0.37	0.12	0.60	0.97	1.72	0.00	Q35@4	0.77	0.63	0.67	1.36	-0.42	0.00
Q35@5	0.05	0.02	0.33	1.15	3.03	0.00	Q35@5	0.42	0.14	0.46	1.21	1.44	0.00
Q36@1	0.00	1.00	NaN	0.57	-999.00	0.00	Q36@1	0.06	0.97	0.22	1.06	-3.52	0.00
Q36@2	0.63	0.28	0.60	0.86	0.91	0.00	Q36@2	0.43	0.84	0.56	0.99	-1.40	0.00
Q36@3	0.37	0.11	0.63	1.02	1.73	0.00	Q36@3	0.76	0.70	0.69	1.36	-0.66	0.00
Q36@4	0.13	0.04	0.46	1.06	2.57	0.00	Q36@4	0.71	0.29	0.55	1.08	0.77	0.00
Q36@5	0.02	0.01	0.18	0.92	4.02	0.00	Q36@5	0.27	0.08	0.38	1.16	1.92	0.00
Q37@1	0.00	1.00	NaN	0.69	-999.00	0.00	Q37@1	0.02	0.99	0.26	1.39	-3.14	0.00
Q37@2	0.77	0.32	0.67	1.11	0.62	0.00	Q37@2	0.39	0.87	0.55	1.07	-1.59	0.00
Q37@3	0.47	0.15	0.66	1.03	1.45	0.00	Q37@3	0.69	0.75	0.64	1.14	-0.90	0.00
Q37@4	0.17	0.06	0.47	0.92	2.40	0.00	Q37@4	0.83	0.39	0.60	1.17	0.36	0.00
Q37@5	0.01	0.00	0.19	1.37	3.62	0.00	Q37@5	0.37	0.11	0.44	1.25	1.60	0.00
Q38@1	0.00	1.00	NaN	0.47	-999.00	0.00	Q38@1	0.04	0.99	0.27	1.39	-2.90	0.00
Q38@2	0.69	0.32	0.62	0.97	0.65	0.00	Q38@2	0.26	0.92	0.50	1.15	-1.92	0.00
Q38@3	0.49	0.19	0.56	0.82	1.39	0.00	Q38@3	0.75	0.77	0.73	1.62	-0.85	0.00
Q38@4	0.14	0.04	0.44	0.94	2.61	0.00	Q38@4	0.88	0.52	0.68	1.46	-0.05	0.00
Q38@5	0.02	0.01	0.13	0.64	5.22	0.00	Q38@5	0.37	0.11	0.41	1.13	1.70	0.00
Q39@1	0.00	1.00	NaN	0.25	-999.00	0.00	Q39@1	0.02	0.99	0.18	1.20	-3.44	0.00
Q39@2	0.70	0.32	0.64	1.03	0.64	0.00	Q39@2	0.29	0.90	0.48	1.02	-1.88	0.00
Q39@3	0.49	0.16	0.68	1.07	1.40	0.00	Q39@3	0.67	0.78	0.63	1.26	-1.00	0.00
Q39@4	0.11	0.03	0.45	1.13	2.62	0.00	Q39@4	0.92	0.51	0.69	1.49	-0.02	0.00
Q39@5	0.00	0.00	0.00	-1.00	-999.00	0.00	Q39@5	0.46	0.15	0.46	1.19	1.38	0.00
Q40@1	0.00	1.00	NaN	0.23	-999.00	0.00	Q40@1	0.04	0.99	0.21	1.39	-3.12	0.00
Q40@2	0.64	0.22	0.65	1.02	1.08	0.00	Q40@2	0.45	0.88	0.68	1.68	-1.38	0.00
Q40@3	0.27	0.08	0.56	1.02	2.03	0.00	Q40@3	0.86	0.72	0.75	1.72	-0.68	0.00
Q40@4	0.05	0.02	0.34	1.11	3.08	0.00	Q40@4	0.81	0.41	0.57	1.06	0.32	0.00
Q40@5	0.00	0.00	0.00	-1.00	-999.00	0.00	Q40@5	0.37	0.11	0.44	1.25	1.60	0.00
Q41@1	0.00	1.00	NaN	0.22	-999.00	0.00	Q41@1	0.02	0.99	0.26	1.67	-3.14	0.00
Q41@2	0.77	0.35	0.68	1.11	0.52	0.00	Q41@2	0.35	0.90	0.66	1.76	-1.55	0.00
Q41@3	0.50	0.16	0.65	1.04	1.42	0.00	Q41@3	0.82	0.77	0.76	1.84	-0.82	0.00
Q41@4	0.11	0.04	0.42	0.95	2.71	0.00	Q41@4	0.81	0.41	0.62	1.29	0.27	0.00
Q41@5	0.00	0.00	0.00	-1.00	-999.00	0.00	Q41@5	0.29	0.08	0.38	1.15	1.87	0.00
Q42@1	0.00	1.00	NaN	0.58	-999.00	0.00	Q42@1	0.02	0.99	0.16	1.09	-3.48	0.00
Q42@2	0.63	0.33	0.56	0.89	0.65	0.00	Q42@2	0.24	0.91	0.40	0.77	-2.24	0.00
Q42@3	0.41	0.14	0.67	1.09	1.50	0.00	Q42@3	0.71	0.76	0.66	1.21	-0.92	0.00

Q42@4	0.21	0.06	0.56	1.12	2.18	0.00	Q42@4	0.88	0.44	0.64	1.34	0.19	0.00
Q42@5	0.01	0.00	0.11	0.79	4.98	0.00	Q42@5	0.37	0.11	0.40	1.12	1.71	0.00
Q43@1	0.00	1.00	NaN	0.75	-999.00	0.00	Q43@1	0.06	0.96	0.14	1.13	-5.15	0.00
Q43@2	0.92	0.53	0.64	1.48	-0.08	0.00	Q43@2	0.47	0.84	0.62	1.23	-1.27	0.00
Q43@3	0.85	0.32	0.74	1.27	0.58	0.00	Q43@3	0.86	0.68	0.70	1.39	-0.56	0.00
Q43@4	0.46	0.13	0.66	1.08	1.55	0.00	Q43@4	0.83	0.33	0.61	1.31	0.55	0.00
Q43@5	0.08	0.02	0.32	0.94	3.12	0.00	Q43@5	0.13	0.04	0.30	1.30	2.28	0.00
							Q44@1	0.02	0.99	0.26	1.52	-3.14	0.00
							Q44@2	0.22	0.93	0.54	1.42	-1.89	0.00
							Q44@3	0.53	0.83	0.69	1.54	-1.15	0.00
							Q44@4	0.79	0.59	0.67	1.29	-0.27	0.00
							Q44@5	0.42	0.13	0.43	1.03	1.58	0.00

APPENDIX 2
ITEM DIMENTIONALITY

	Pre-Test			Post-Test	
ITEM	PVal	Loading	ITEM	PVal	Loading
Q25@1	1.00	0.00	Q25@1	0.99	0.45
Q25@2	0.52	0.48	Q25@2	0.93	0.64
Q25@3	0.36	0.52	Q25@3	0.80	0.60
Q25@4	0.09	0.66	Q25@4	0.54	0.56
Q25@5	0.01	0.05	Q25@5	0.08	0.27
Q26@1	1.00	0.00	Q26@1	0.99	0.45
Q26@2	0.70	0.42	Q26@2	0.94	0.64
Q26@3	0.45	0.55	Q26@3	0.85	0.72
Q26@4	0.15	0.56	Q26@4	0.61	0.63
Q26@5	0.00	0.00	Q26@5	0.11	0.27
Q27@1	1.00	0.00	Q27@1	0.98	0.46
Q27@2	0.39	0.60	Q27@2	0.92	0.66
Q27@3	0.21	0.66	Q27@3	0.82	0.70
Q27@4	0.09	0.55	Q27@4	0.48	0.58
Q27@5	0.00	0.00	Q27@5	0.07	0.28
Q28@1	1.00	0.00	Q28@1	0.99	0.45
Q28@2	0.34	0.68	Q28@2	0.92	0.65
Q28@3	0.20	0.68	Q28@3	0.79	0.75
Q28@4	0.03	0.54	Q28@4	0.42	0.57
Q28@5	0.00	0.00	Q28@5	0.08	0.31
Q29@1	1.00	0.00	Q29@1	0.99	0.45
Q29@2	0.47	0.64	Q29@2	0.91	0.71
Q29@3	0.27	0.69	Q29@3	0.80	0.71
Q29@4	0.13	0.59	Q29@4	0.44	0.55
Q29@5	0.01	0.28	Q29@5	0.11	0.34
Q30@1	1.00	0.00	Q30@1	0.98	0.45
Q30@2	0.36	0.64	Q30@2	0.89	0.70
Q30@3	0.17	0.69	Q30@3	0.74	0.69
Q30@4	0.06	0.57	Q30@4	0.41	0.58
Q30@5	0.00	0.24	Q30@5	0.07	0.31
Q31@1	1.00	0.00	Q31@1	0.99	0.45
Q31@2	0.29	0.62	Q31@2	0.89	0.71
Q31@3	0.10	0.64	Q31@3	0.74	0.70
Q31@4	0.04	0.48	Q31@4	0.41	0.54
Q31@5	0.00	0.24	Q31@5	0.09	0.34
Q32@1	1.00	0.00	Q32@1	0.99	0.45
Q32@2	0.49	0.62	Q32@2	0.88	0.75
Q32@3	0.20	0.70	Q32@3	0.79	0.78
Q32@4	0.08	0.54	Q32@4	0.43	0.58
Q32@5	0.01	0.22	Q32@5	0.06	0.24
Q33@1	1.00	0.00	Q33@1	0.99	0.45

Q33@2	0.38	0.49	Q33@2	0.92	0.70
Q33@3	0.16	0.64	Q33@3	0.81	0.73
Q33@4	0.05	0.56	Q33@4	0.52	0.61
Q33@5	0.01	0.27	Q33@5	0.07	0.25
Q34@1	1.00	0.00	Q34@1	0.99	0.39
Q34@2	0.70	0.45	Q34@2	0.96	0.53
Q34@3	0.43	0.64	Q34@3	0.87	0.62
Q34@4	0.19	0.65	Q34@4	0.67	0.66
Q34@5	0.02	0.43	Q34@5	0.20	0.41
Q35@1	1.00	0.00	Q35@1	0.99	0.39
Q35@2	0.56	0.58	Q35@2	0.95	0.60
Q35@3	0.34	0.71	Q35@3	0.87	0.72
Q35@4	0.12	0.62	Q35@4	0.63	0.64
Q35@5	0.02	0.39	Q35@5	0.14	0.37
Q36@1	1.00	0.00	Q36@1	0.97	0.28
Q36@2	0.28	0.58	Q36@2	0.84	0.58
Q36@3	0.11	0.66	Q36@3	0.70	0.68
Q36@4	0.04	0.52	Q36@4	0.29	0.47
Q36@5	0.01	0.22	Q36@5	0.08	0.30
Q37@1	1.00	0.00	Q37@1	0.99	0.39
Q37@2	0.32	0.65	Q37@2	0.87	0.58
Q37@3	0.15	0.67	Q37@3	0.75	0.63
Q37@4	0.06	0.52	Q37@4	0.39	0.53
Q37@5	0.00	0.24	Q37@5	0.11	0.35
Q38@1	1.00	0.00	Q38@1	0.99	0.36
Q38@2	0.32	0.60	Q38@2	0.92	0.54
Q38@3	0.19	0.56	Q38@3	0.77	0.73
Q38@4	0.04	0.48	Q38@4	0.52	0.62
Q38@5	0.01	0.14	Q38@5	0.11	0.33
Q39@1	1.00	0.00	Q39@1	0.99	0.27
Q39@2	0.32	0.61	Q39@2	0.90	0.51
Q39@3	0.16	0.69	Q39@3	0.78	0.62
Q39@4	0.03	0.50	Q39@4	0.51	0.62
Q39@5	0.00	0.00	Q39@5	0.15	0.38
Q40@1	1.00	0.00	Q40@1	0.99	0.29
Q40@2	0.22	0.63	Q40@2	0.88	0.72
Q40@3	0.08	0.58	Q40@3	0.72	0.73
Q40@4	0.02	0.38	Q40@4	0.41	0.50
Q40@5	0.00	0.00	Q40@5	0.11	0.35
Q41@1	1.00	0.00	Q41@1	0.99	0.39
Q41@2	0.35	0.65	Q41@2	0.90	0.72
Q41@3	0.16	0.66	Q41@3	0.77	0.75
Q41@4	0.04	0.45	Q41@4	0.41	0.55
Q41@5	0.00	0.00	Q41@5	0.08	0.31
Q42@1	1.00	0.00	Q42@1	0.99	0.25
Q42@2	0.33	0.53	Q42@2	0.91	0.44

Q42@3	0.14	0.70	Q42@3	0.76	0.65
Q42@4	0.06	0.60	Q42@4	0.44	0.56
Q42@5	0.00	0.11	Q42@5	0.11	0.33
Q43@1	1.00	0.00	Q43@1	0.96	0.17
Q43@2	0.53	0.60	Q43@2	0.84	0.65
Q43@3	0.32	0.72	Q43@3	0.68	0.69
Q43@4	0.13	0.69	Q43@4	0.33	0.53
Q43@5	0.02	0.37	Q43@5	0.04	0.24
			Q44@1	0.99	0.39
			Q44@2	0.93	0.61
			Q44@3	0.83	0.73
			Q44@4	0.59	0.62
			Q44@5	0.13	0.35

**. Correlation is significant at the 0.01 level (2-tailed).

APPENDIX 3
Questionnaires for Pre-Test

KZN CoLab @ durban university of technology

E-skills institute knowledge and coordination production hub

e-skilling the nation for equitable prosperity and global competitiveness

The aim of this pre-training assessment is to determine your current working conditions and your level of skill and expertise in the field of Information and Communication Technology (ICT). This is required to ensure that you find the training you are about to engage with stimulating and interesting.

The results of this pre-training assessment will not impact on your position at all and will be treated as confidential. All results published will be anonymous; it will not identify any individuals.

Please answer all the questions truthfully as the aim is to maximise the impact of the training.

A. BIOGRAPHICAL DETAILS:
Please give some personal details

1. **Surname, Initials**

2. Gender (Mark with an X) :

Male   Female

3. Email

4. Telephone numbers:

Work:										
Cell:										

5. Please state your area of work:

6. Can this area best be described as: (Mark with an X in both rows a and b)

(a)	**Urban (City)**	**Semi-Urban**	**Rural**
(b)	**Advantaged**	**Marginalized**	**Disadvantaged**

7. **Describe, in a few words, your specific area of job responsibility.**

____

8. Describe, in a few words, how community development service delivery has been improved in the last 3 years.

____

9. What do you think would be the benefits of using ICT in your job?

____

10. What do you expect to gain from the e-Skills training program?

____

11. Why are you participating in the e-Skills training program?

____

B. ENVIRONMENTAL DETAILS:
Please give some details about the available equipment at the place where you work.

13. Which of the following devices do you have access to? (Mark all those you have)

Device	Mark with X
Desktop computer	
Tablet	
Laptop	
Smartphone	
Other (please specify)	

14. Do you have internet access? [Yes] [No]

If you answered "No" to this question, **please go to question number 17.**

15. Please indicate in the following table the quality of your internet connection:

Quality of connection	Mark with X
Very fast	
Fast	
Workable	
Slow	
Very slow	

Very reliable (never drops connection)	
Mostly reliable	
Does drop connection sometimes	
Regularly drops connection	

16. Please indicate how often you access the internet.

Frequency of use	Mark with X
More than once per day	
Once per day	
Once per week	
Once per month	
Never	

WORK REQUIREMENTS
Please give some details about your work.

17. Please mark which of the following tasks you do.

Tasks	Mark with X	How Often: Mark with X		
Write reports		Daily	weekly	monthly
Email people		Daily	weekly	monthly
Provide information to individuals		Daily	weekly	monthly
Talk to groups of people		Daily	weekly	monthly
Attend meetings		Daily	weekly	monthly
Phone people		Daily	weekly	monthly
Search for information		Daily	weekly	monthly
Provide forms for people to complete		Daily	weekly	monthly
Sms groups of people		Daily	weekly	monthly
Submit a budget or financial statement		Daily	weekly	monthly

18. Please indicate whether you currently use technology to use to do the following tasks:

Tasks	Currently use ICT Technology: Mark with X	
Write reports	Yes	No
Provide information to individuals	Yes	No
Talk to groups of people	Yes	No
Attend meetings	Yes	No
Make appointments	Yes	No
Search for information	Yes	No
Provide forms for people to complete	Yes	No
Communicate with groups of people	Yes	No
Submit a budget or financial statement	Yes	No

19. Of those tasks you marked in question 11, please indicate what percentage of your time per day these tasks take to complete

Tasks	Mark with X			
Write reports	Less than 10%	10-30%	30-50%	50% and more
Email people	Less than 10%	10-30%	30-50%	50% and more
Provide information to individuals	Less than 10%	10-30%	30-50%	50% and more
Talk to groups of people	Less than 10%	10-30%	30-50%	50% and more
Attend meetings	Less than 10%	10-30%	30-50%	50% and more
Phone people	Less than 10%	10-30%	30-50%	50% and more
Search for information	Less than 10%	10-30%	30-50%	50% and more
Provide forms for people to complete	Less than 10%	10-30%	30-50%	50% and more
Sms groups of people	Less than 10%	10-30%	30-50%	50% and more
Submit a budget or financial statement	Less than 10%	10-30%	30-50%	50% and more

BIOGRAPHICAL DETAILS:
Please give some details about your own background.

20. Please mark your level of education.

Education	Mark with X
Grade 10 or lower	
Grade 11	
Grade 12	
Post grade 12 education	
Other (please specify)	

21. Have you had any formal training in using computers?

Yes	No

22. Please indicate you level of competence using a computer.

Computer competence	Mark with X
Very competent	
Average	
Low level of competence	
Have not used a computer before	

23. Please indicate applications you use on your computer.

Cell phone applications	Mark with X
Word processor	
Presentation software	
Spread sheet	
Email	
MIS	
Other	

I don’t use any	

24. Please indicate applications you use on your cell/smart phone.

Cell phone applications	Mark with X
WhatsApp	
Facebook	
Twitter	
BBM	
Google	
Other	
I don’t use any	

SELF ASSESSMENT OF ICT SKILLS LEVEL:

Please assess your level of skills in the following, by marking the column with an X. If the technology is unknown to you, assess your skill at level 1

Item	1 No skill	2 Limited	3 Average	4 Good	5 Expert
25. To what extent can you use a word processor to create a human settlement report?					
26. To what extent can you use a document template to report poverty issues to an information manager?					
27. To what extent can you use electronic presentation software such as PowerPoint to create and convey information on HIV/AIDS awareness?					
28. To what extent can you use presentation software to create appropriate posters to manage utilities usages, human right and civil responsibility issues?					
29. To what extent can you use a search engine (search engine in a government portal/website) to discover crop management information?					
30. To what extent can you use a search engine (search engine in a government portal or a website) to access crop market prices?					
31. To what extent can you use a search engine (search engine in a government portal or a website) to supply chain tender?					

32.	To what extent can you use a search engine (search engine in a government portal/website) to find funding opportunities, donors and development agencies?					
33.	To what extent can you use an electronic spreadsheet to analyze data?					
34.	To what extent can you use social media (sms, email, twitter) to facilitate mobile interaction between community members and government representatives?					

	Item	**1 No skill**	**2 Limited**	**3 Average**	**4 Good**	**5 Expert**
35.	To what extent can you use a government portal/website to access and download government agency related information and forms?					
36.	To what extent can you use a Really Simple Syndication (RSS) feeds reader to collect information?					
37.	To what extent can you use electronic media to synchronize calendars on mobile and desktop devices?					
38.	To what extent can you use electronic media to set up a meeting across and within different spheres of government?					
39.	To what extent can you use electronic media to set up a group on an email account?					
40.	To what extent can you use an electronic spreadsheet to set up a financial budget?					
41.	To what extent can you use electronic media to capture associated data in a structured format?					
42.	To what extent can you use social media to create new networking collaboration?					
43.	To what extent can you use search engines to access government information and services (health, agriculture, education, funding, aviation, tourism)?					

APPENDIX 4
Questionnaires for Post-Test

KZN CoLab @ durban university of technology

E-skills institute knowledge and coordination production hub

e-Skills Institute

e-skilling the nation for equitable prosperity and global competitiveness

The aim of this post-training assessment is to determine the impact the training has had on your current working conditions and your level of skill and expertise in the field of Information and Communication Technology (ICT). This is required to ensure that the training you received was of value to you.

The results of this post-training assessment will not impact on your position at all and will be treated as confidential. All results published will be anonymous; it will not identify any individuals.

Please answer all the questions truthfully as the aim is to maximise the impact of the training.

A. Quantitative Post-Assessment Model

Please tick in the column you feel most appropriate.

	Item	1 No skill	2 Limited	3 Average	4 Good	5 Expert
1	My skills to create a human settlement report, using a word processor, have improved as a result of e-skills training program?					
2	My skills to report poverty issues to my information manager using a document template have improved as a result of e-skills training program?					
3	My skills to create and convey information on HIV/AIDS awareness using electronic presentation software have improved as a result of e-skills training program?					
4	My skills to create suitable posters to manage utilities usages, human right and civil responsibilities issues using presentation software have improved as a result of e-skills training program?					

5	My skills to discover crop management information from a government portal or website using a search engine have improved as a result of e-skills training program?					
6	My skills to access crop market prices from a government portal or website using search engine have improved as a result of e-skills training program?					
7	My skills to search for supply chain tender in a government portal or a website using search engine have improved as a result of e-skills training program?					
8	My skills to find funding opportunities, donors and development agencies in a government portal or website using search engine have improved as a result of e-skills training program?					
9	My skills to analyze data using spreadsheet software has improved as a result of e-skills training program have improved as a result of e-skills training program?					
	Item	**1 No skill**	**2 Limited**	**3 Average**	**4 Good**	**5 Expert**
10	My skills to facilitate mobile interaction between community members and government representatives using social media (sms/email/Twitter/Facebook) have improved as a result of e-skills training program?					
11	My skills to access and download government agency related information and forms using a government portal or a website have improved as a result of e-skills training program?					
12	My skills to collect information using Really Simple Syndication (RSS) feeds reader have improved as a result of e-skills training program?					
13	My skills to synchronize calendars on mobile and desktop devices using electronic media have improved as a result of e-skills training program?					

14	My skills to set up a meeting across and within different spheres of government using electronic media have improved as a result of e-skills training program?					
15	My skills to set up a group on an email account using electronic media have improved as a result of e-skills training program?					
16	My skills to set up a financial budget using an electronic spreadsheet have improved as a result of e-skills training program?					
17	My skills to capture associated data in a structured format using electronic media have improved as a result of e-skills training program?					
18	My skills to create new networking collaboration using social media have improved as a result of e-skills training program?					
19	My skills for conflict resolution using ICT have improved as a result of e-skills training program?					
20	My skills in accessing government information and services (health, agriculture, education, funding, aviation, tourism) using search engines have improved as a result of e-skills training program?					

B. Quantitative Post-Assessment Satisfaction Model

Indicator	Conceptual Measure	Strongly disagree=1	Disagree= 2	Neutral=3	Agree=4	Strongly agree=5
Expectation	The attitude of the program trainers is good towards me					
	The trainers are well knowledgeable and skilful					
	The quality of training resources is of high standard					

	The training program stimulates my interest to learn more					
	Overall, the training program meets my needs					
Perceived quality	The training program incorporated humor to stimulate my learning ability					
	I felt relaxed during the training program					
	The training program included a test to evaluate the skills I acquired					
	The training program was directed to skills related to my job					
	The training was conducted in a quality facility					
	The trainer was well knowledgeable, skillful and confident					
Perceived value	The training program helps improve my ICT skills					
	The training program helps to improve my self-efficacy to use ICT					
	The training program helps me to acquire skills that will make me more productive at work place					
	The training program is not costly in terms of money and time					
	The training program is quite appropriate, timely and above all very resourceful compare to other trainings.					
Indicator	**Conceptual Measure**	**Strongly disagree=1**	**Disagree= 2**	**Neutral=3**	**Agree=4**	**Strongly agree=5**
Image	The training program was well conducted					
	The training has helped me to realize my talent and it has well raised high the name of this country					
	The training had built and expanded my past experience					

	I receive adequate and timely feedbacks to questions I ask					
Loyalty	I will recommend the training program to colleagues					
	I will attend the training program if organize again					
	I will spread positive word-of-mouth about this training program					
	I will always make reference to the e-skill trainers for the impact and encouragement I have received.					
Complaint	I have complaints with the structure of the training program					
	I have complaints with the quality of resources (trainer, learning materials)					
	I have complaints with the quality of the program content					
	I would like a repeat of a session of the training because it is boring and difficult					
	The trainer does not always answer my question correctly as expected					
Satisfaction	The time spent so far on the training is not a waste					
	The trainer is friendly and easy to contact					
	The training adequately met my aspiration in the present job at hand?					
	I can offer resources to promote the training because I am satisfied with the whole setting of the training program.					
	Overall, I am satisfied with the training program					