A critical review of ICT-enabled development influencing the quality and quantity of South African tertiary education students

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ABSTRACT

There is a shortage of information systems (IS) professionals in South Africa. This IS skills shortage is growing, as attempts to reduce the scarcity of IS skills through (i) ICT-enabled education-focussed development and (ii) IS education initiatives are not increasing IS skills levels in South Africa fast enough to keep up with global growth trends in IS skills. The South African demand for tertiary-level IS skills continues to outgrow the supply.

This study aims to explain the nature of this skills shortage, and to address this shortage by finding ways to increase the quantity and quality of students enrolling for and graduating in IS [and IS-related] graduate courses at tertiary education institutions in South Africa. This study, in three sequential parts, finds (i) ways to improve the impact and sustainability of existing ICT-enabled education-focussed development projects, (ii) reasons and solutions for the lack of tertiary level IS students (and graduates) from a human capacity-building perspective, and (iii) meaningful results from two case study projects engaged in by the researcher that suggest short transition and reskilling courses as a workable solution to the mentioned skills shortage.

The findings from these three parts lead to practical considerations for South African IS departments, informed by a graduate development framework, that will guide IS departments towards optimising the quality and quantity of tertiary-level IS students in South Africa. The resulting framework, the IS Graduate Development Framework, includes a sensitivity towards increasing the employability and entrepreneurial potential of IS students. The results from using the framework as measuring tool include several new insights regarding the kind of IS development project [or course] that best facilitates the development of more high-quality, industry-ready IS graduates, and lead to practical improvements in existing IS courses at a local university. These improvements include the development of a mobile application, as part of one of the case study projects, to facilitate higher levels of industry involvement, sufficient information delivery, changing popular perceptions of IS, and long-term relationships with students that can be used to motivate student career choice.

KEYWORDS

Information and communication technology; Information systems; Labour market; Innovation; ICT skills; Graduate development; Capacity building; Mobile application development; Creative industry labour

DECLARATION

I, Johan Breytenbach, declare that

A critical review of ICT-enabled development influencing the quality and quantity of South African tertiary education students

is my own work and that all sources used and/or quoted have been indicated.

All the sources are acknowledged by means of a complete bibliography.

The thesis was language edited by: Marisa Honey

with qualification: MPhil (Translation), Translation Studies (cum laude).

Johan Breytenbach

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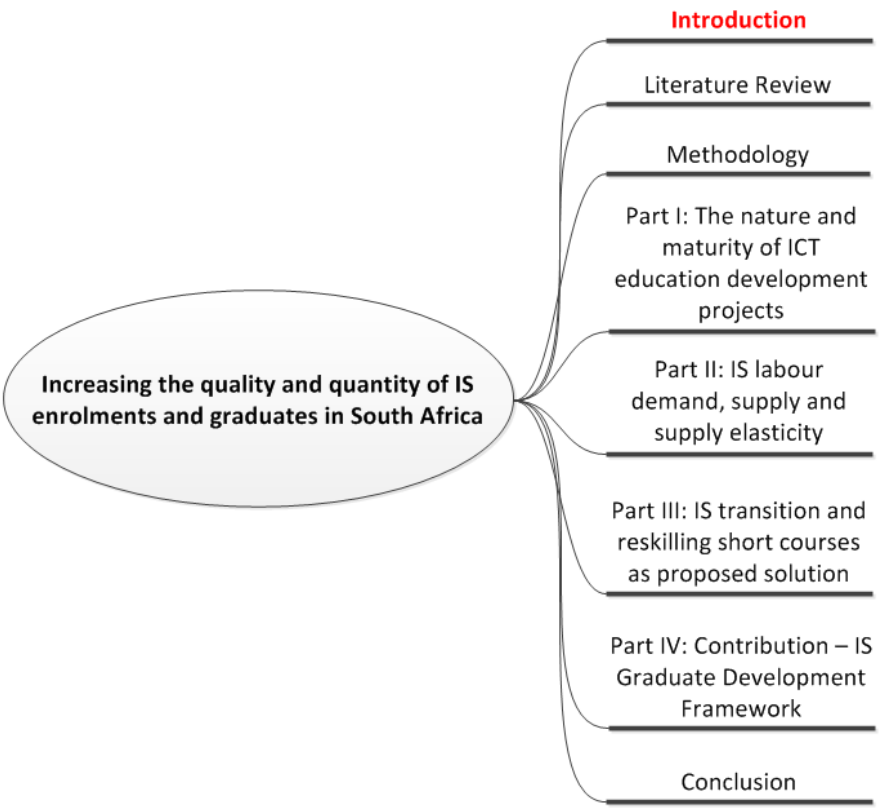
CHAPTER 1: INTRODUCTION



1.1 Introduction

> "*Change of any magnitude automatically means that we have to let go of things we know how to do, and to implement things that are new and different. This is one of the core attributes of leadership*."
> – Christo Nel, in *Transformations without sacrifice (2010)*

In this chapter the researcher discusses how the research concept for this thesis was developed from a preliminary reading of the literature, how this thesis forms part of an important information systems (IS) discourse – the IS skills shortage in South Africa – and how this thesis was designed to achieve the development of a tangible contribution in the form of a framework that contributes to IS theory – the IS Graduate Development Framework (ISGDF).

This introductory chapter guides the reader through background information concerning the IS skills shortage debate in South Africa, how this research addresses this skills shortage, notes regarding the researcher's research philosophy throughout the duration of this study, a short description of the current industry demand for IS skills in South Africa, and notes on student capability. The reader is then presented with a description of the structure of this thesis, as the thesis does not follow the conventional form. This introductory chapter concludes with [culminates in] the formal presentation of the research question of this study. Figure 1 provides a visual outline of this chapter. The purpose of the visual outlines found throughout this study is discussed later in the Argument drawings section.

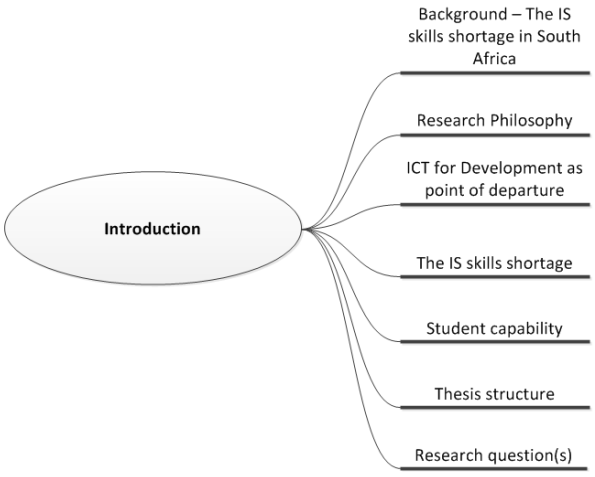


Figure 1: Example of visual argument outlines found in this text

1.2 Background – the IS skills shortage in South Africa

There is a shortage of information systems (IS) professionals in South Africa, and the researcher argues that an insufficient supply of high-quality IS enrolments [and therefore graduates] is the primary cause of this shortage. This IS skills shortage is growing, as attempts to reduce the scarcity of graduate-level IS skills through (i) ICT infrastructure development projects, (ii) ICT-enabled education-focussed development and (iii) IS education initiatives are not increasing the level of IS skills in South Africa fast enough to keep up with global IS skills growth trends. The South African demand for tertiary-level IS skills continues to outgrow the local graduate supply.

This thesis aims to further the current understanding of the South African IS skills deficiency with a critical contribution regarding the nature and maturity of skills development projects (Part 1), and by addressing this skills shortage by finding ways to increase the quantity and quality of students enrolling for and graduating in IS [and IS-related] graduate courses at tertiary education institutions in South Africa. Included in the scope of this thesis is the practical task of guiding an IS/IT (information technology) department and involved industry stakeholders through the graduate development process until the process has reached a level of maturity that ensures sustainability. This is done by providing stakeholders with an IS Graduate Development Framework as part of the contribution of this study (Part 4), and facilitating IS courses informed by this framework (Part 3, Part 4).

Key findings of this study include observations about (i) the lack of maturity of ICT development projects (both infrastructure and education projects), (ii) variables that can be used to increase the elasticity of IS graduate supply (Part 2), and (iii) the value of industry-sensitive transition and reskilling programs to stimulate a high-quality increase in IS graduate supply. The results and findings of this study, presented as four chapters in article format, are combined into a framework in the fourth results chapter (Part 4) – the IS Graduate Development Framework – that can be used by IS departments to stimulate graduate numbers and increase the level of employability and innovation potential of such graduates. The suggested framework is applied – this process is described as a case study that informs Part 4 of this thesis, with this action resulting in several practical improvements made to the case study project in Part 4. These improvements include the development of a mobile application that facilitates some of the key success factors of IS graduate development projects.

1.2.1 A timely, contextualised solution

This study joins the discourse regarding the IS skills deficiency in South Africa at a critical time. In 2010 the South African Department of Communications (DoC) publicised research on the lack of e-skills, including much needed tertiary-level IS skills, in South Africa and launched the National e-Skills Plan of Action (NeSPA) (NeSPA, 2010). NeSPA, in brief, was a collection of development initiatives, some of them to be rolled out by IS departments at universities across South Africa, that aimed at addressing the mentioned e-skills shortage. NeSPA confirmed that the e-skills shortage was on the South African government's agenda.

In this thesis the term e-skills is used to describe the collection of skills used by (i) research and development practitioners, (ii) ICT practitioners, (iii) ICT users, (iv) e-business practitioners, and (v) e-literate computer users (Vanska, Fiuczynski, Steib, & Thatcher, 2008). The researcher often refers to information systems (IS) practitioners and information systems (IS) skills as a smaller subset of technical skills. These information systems skills form part of groups (i) and (ii) in the definition of e-skills.

Popular media in South Africa have been echoing the government findings regarding the shortage of e-skills – and government's sense of urgency regarding skills development – since 2010[1]. It was reported that the number of IS graduates was too few to fill the large number of available [publicly advertised] IS professional positions (Cremer, 2011). As this text unfolds, readers will be provided with a detailed analysis of the IS skills shortage (see Part 2 of this study), and education-based solutions to this shortage (see Part 3 and Part 4 of this study).

Important to note from the outset of this study is that the South African *e-skills* shortage, which includes the *IS skills* shortage, is not a new challenge in South Africa. This is a maturing discourse, one that all major stakeholders (including government) are aware of (Alexander *et al*., 2011; Twinomurinzi, 2012), and one for which several action plans towards recovery have been generated, with the Department of Communication's (DoC) e-Skill Institute (eSI) taking the lead on behalf of the South African government[2]. This is a complex debate about an increasingly severe problem within the core (technical) IS industry and peripheral industries that use embedded IS labour. As yet (2013),

[1] As an example see Mawson, N. (2011). Demand grows for IT skills. *ITWeb Business.* [Online] Available at: http://goo.gl/HMXhQ

[2] e-Skills Institute publications available online: http://goo.gl/mhqn8

previously proposed solutions have not delivered the required increase in skills, which justifies the critical stance taken by the researcher throughout this study[3]. A detailed account of the current state of affairs within the skills shortage debate was presented at the 2nd National e-Skills Summit held in October 2012[4]. A part of this thesis was presented for critique at the ResNes doctoral students' colloquium that coincided with the Summit. More information regarding the presentation of the findings at this doctoral student colloquium is available in Appendix 6.

In 2011, the South African government's e-skills action plan (NeSPA, 2010) started taking shape as the five participating South African universities moved into action. It was expected of each university to launch an e-skills hub – an institution that would generate the skills identified as lacking in the ICT and IS industries. (See section 1.6, The IS skills shortage, for a breakdown of these skills.) In 2011, the NeSPA initiative thus became part of a collection of existing projects aimed at addressing the shortage of e-skills (and IS skills in particular) in South Africa. It is this collection of projects that the researcher has in mind when the investigation in Part 1 starts with a review of skills and infrastructure development projects.

The mentioned 2nd National e-Skills Summit resulted in a revised version of NeSPA (NeSPA, 2012). The following two "major issues" form part of the list of updated e-skills concerns published in the revised version of NeSPA:

- the requirement for clear guidance frameworks to encourage the development of transferable skills and skills that are most in demand; and
- the need for skills development, training and services to be made available on multiple delivery and structural platforms and particularly on mobile devices.

This is where this thesis joins the debate. In this study the researcher investigates the IS skills shortage in three consecutive studies, guided by three research questions that pertain to the mentioned skills shortage debate. An informal, introductory overview of the three studies follows. For a more detailed description of each research study, see the Thesis Structure and Methodology and Research Design sections later in this text.

[3] The critical nature of parts of this research study is discussed in the Preliminary Literature Review chapter.

[4] 2nd National e-Skills Summit, 22-25 October 2012, information available online: http://goo.gl/ukH7W

(1) **Why are the current ICT-enabled e-skills development and IT/IS education development projects (collectively and individually) not producing the required results?** This part of the study is structured as a critical look at the nature of these development projects, followed by suggestions about how such projects, including government-funded programmes [such as NeSPA] and industry-funded initiatives (Cremer, 2011), can be tweaked to mature faster towards sustainability and hence have a greater chance of success. Economic development theory, including the work of Sen (1999, 2009) and current IT project maturity model theories, is used to inform these chapters. The section of this study answering the first research question (Part 1) can be classified as ICT for Development (ICT4D) research, with both an infrastructure and an education development focus. When education development is mentioned in this section it includes, but is not limited to, tertiary-level IS education.

(2) **Why are so few students (and so few good students) choosing IS or IT as study field or career choice?** To make this question more pertinent, it is noted that attainable IS and IT jobs are abundantly available in South Africa (discussed in section 1.6, The IS skills shortage), and that these jobs promise good financial security and industry stability to potential IS graduates. The part of this study that answers the second research question (Part 2) was approached using a more quantitative approach and includes a large-scale questionnaire (answered by 4 475 tertiary-level students) asking students analytical questions about their study and career choices and why they decided to choose (or not choose) IS and related IT degrees as a field of study. This section of the study can be classified best as IS in Education research, although ICT4D influences are evident throughout.

(3) **Can short transition and reskilling courses be used as intervention projects to fill skills gaps in the IS graduate supply chain?** This part of the study (Part 3) provides the reader with two case study examples of how short courses in mobile application development have been used to increase not only the quality and quantity of IS enrolments and graduates, but also the level of employability of such students. This part of the study follows an action research approach (explained in detail later), and yields quantitative findings from two separate case studies. This section builds on the foundational results from Part 1 and Part 2 of the study.

Answering these three questions together in the same study yields previously unpublished insights and several practical benefits for IS departments. These benefits will become apparent as readers progress through the text, but an example is in order. The role of teachers in education-focussed ICT development projects often receives little attention in the ICT4D study field (the focus of the first

part, Part 1, of this study), whereas in this study the researcher was forced to consider teachers as a major influence [variable] in education-focussed ICT4D because of the findings relating to IS education and reasons for the IS skills shortage (the focus of the second part, Part 2, of the study). The interaction between ICT4D influences and IS for education influences in this study gives the reader a clearer picture of the problem domain (how complex it is), and guides us towards both a more sensitive solution to the problem, and interesting new research avenues. It is through the combination of findings from Part 1, Part 2 and Part 3 in the contributory chapters of this thesis (Part 4) that this thesis achieves its goals – a revision of the readers' current understanding of the e-skills deficiency in South Africa, and a new solution to this problem – a development framework that assists IS departments with graduate development (increasing the quality and quantity of their students). This new framework, called the IS Graduate Development Framework (ISGDF), is implemented within the context of the existing e-skills debate, tested, and found successful in the contributing sections of this text (Part 4).

1.3 Research philosophy

Before delineating the scope and problem domain of this thesis and the research question(s) at hand, three introductory comments are made regarding the research philosophy behind this study. This will help readers to follow the major arguments in this text with greater ease, and prevent the argument from getting cluttered with redundant philosophical side notes.

1) The researcher has a keen interest in the influence of the media, including social recognition and celebration, on both ICT4D projects and education-focussed IS development projects. The effect of "new media" concepts such as mobile marketing is also a secondary avenue of interest for the researcher. The interaction between media exposure and technology development is a field of study that has received very little attention, with the study by Chigona and Mooketsi (2011) being one of the few South African examples. Throughout this study, mention will be made of any significant (observed) influence of the media [and social recognition] on the research projects at hand. The effect of media on IS graduate development was deemed important enough to include it as a variable in the suggested graduate development framework. Results from the application of the framework, and the mentioned interest in new media applications, resulted in the development of a mobile application that complements the framework. The influence of this application on graduate development falls beyond the scope of this study, but can be pursued as an interesting future research study.

2) Before commencing with this study in 2010 it was decided to move away from popular reasoning patterns that prematurely link the e-skills shortage and ICT4D initiatives to the population groups labelled as "previously disadvantaged" in South Africa. Throughout the study the researcher tried to be sensitive regarding underlying assumptions (by all stakeholders) regarding historical influences on graduate development, and rather focussed on spreading the research population (and translating the findings) across the entire socio-economic spectrum, while rejecting the rhetoric closure (Pozzebon, Titah, & Pinsonneault, 2006) brought about by simply ascribing the e-skills shortage [or a lack of IS knowledge] to the often generalised historical social conditions in South Africa. Even when the researcher was involved with ICT4D projects that targeted community members that could be classified as historically disadvantaged (and, regrettably, sometimes classified as such by themselves), care was taken to remove such reasoning (underlying assumptions) from the philosophy underpinning this study. To make this shift possible in the mind of the researcher, some basic epistemological guidelines were used to make sure the study used the *individual capabilities of students* as reference, rather than their current or historic economic position of (dis)advantage. These student capability guidelines [philosophy] will be discussed briefly in section 1.8, The concept of student capability. Using the findings from Part 1 and Part 2 of this study as motivation, no variables that measure a lack of infrastructure or education as a direct result of historical disadvantage were included in the contributory framework presented in Part 4. The adoption of this research approach is an example of the researcher being sensitive to underlying validity claims within the IS skills shortage discourse, and gives the first part of the study a critical emancipatory character. Critical emancipatory IS research is discussed in the preliminary literature review of this study.

3) Thirdly, the researcher is aware of the difficulties surrounding the measurement of e-skills development (e.g. quantifying the industry need for specific skills), as discussed by Cremer (2011) and Calitz (2011). Moreover, the researcher understands the general concerns associated with measuring social development and, in turn, the success of social development projects, including the potential lack of rigor ascribed to research of this nature. The maturity, sustainability and developmental impact of IS education development and ICT-enabled education development projects are difficult to measure [quantify].

   Throughout this study, the works of Sen, particularly his views on development as measurable increases in freedom (Sen, 1999), were used as a guide when measuring the

developmental impact of projects. In short, if no visible [measurable] increase in economic or social *freedom* could be reported, by definition then no *development* occurred. Informing the ICT4D field and the IS education field with the economic philosophies of Sen proved to be fruitful throughout the duration of this study, and an in-depth discussion of the concept of development as freedom is provided in this text (see the introductory sections of Part 1). Sen's work gave the researcher a way of increasing the measurability of the outcomes of ICT development projects that are social in nature, and hence the ability to increase the rigor of the research through well-defined measures and data analysis. While only at the starting point of reading this study, readers are encouraged to inform their views on technology development with an understanding of Sen's work, especially his capability approach to development (Sen, 1999). Development-oriented information systems projects can benefit greatly from this interdisciplinary pollination process between economic development theory and technology development processes. This observation has been underlined by a detailed discussion of the IS-applicable parts of Sen's work in accredited IS literature (Andersson, Grönlund, & Wicander, 2012).

1.4 ICT for development

The question might be asked why this IS education study starts with a chapter focussing on ICT for development (ICT4D) concepts. This is a valid question, as the entire first results chapter of this thesis, Part 1, can be classified as ICT4D research. The reason for using ICT4D as starting point lies in the nature of this study. This research, focussed on community-based graduate development projects, has a social character in that it discusses human development, community development, and the developmental effect of technology (artefact and education) on social structures.

Throughout Part 1 of this text, care was taken to provide sufficient social theory as foundation for the social nature of this ICT4D research. Accepted social and economic theories – including formative work by Giddens (1984), Habermas (1984), and Sen (1999) [referenced in Part 1] – were used to create a socially sensitive grounding for this study. Again the work of Sen is mentioned concerning measurable development variables, and the capability approach (Sen, 1999) is regarded as the philosophic point of departure for this study that provides the reader with a socially and economically informed vocabulary with which to discuss (and, as in this study, critique) infrastructure or education-driven IS development projects. Since Part 1 serves as building block for Part 2 and Part 3 of this text, with the findings from Part 1 flowing into further arguments, the social

and economic sensitivity that characterises the ICT4D starting position of this study is pervasive throughout the text.

1.5 A note regarding prior reading

This study originated from prior readings within the fields of IS research, social theory, and the nature of ICT4D projects. For a detailed layout of the literature used to gradually clarify the topic of this study and support this thesis from within IS literature, refer to the Preliminary Literature Review chapter. As the study progressed, several other literature sources were used as grounding. These sources are referenced conveniently at the end of each of the four results chapters.

1.6 The IS skills shortage

This section provides background information pertaining to the subject of the thesis – the IS skills shortage in South Africa.

The primary focus of this study was addressing the South African IS skills shortage through IS education-focussed development projects. This IS skills deficiency, and potential solutions of it, are discussed in full in Part 2, Part 3 and Part 4 of this text. In this introductory section, a brief overview of the current (2012) South African IS skills shortage landscape is provided to give the reader sufficient background knowledge while reading Part 1. In order for the text not to become repetitive, this section is brief – the nature of the IS skills shortage is discussed expansively throughout the thesis.

The IS skills shortage around which this study revolves forms part of the greater e-skills deficiency in South Africa, as described in the NeSPA DoC documentation (NeSPA, 2010) and recently summarised by Cremer (2011) and Calitz (2011).

This study joins the ICT skills shortage debate of 2011/2012. During this time, the South African government institution responsible for ICT skills development, the Media, Information and Communication Technologies Sector Education and Training Authority (MICT SETA), published ICT skills shortage statistics based on information gathered from industry partners (companies registered as members of the MICT SETA), for the period 2009 to 2011 (MICT SETA, 2011). A list of relevant *IS skills* from this publication is extracted and presented in Table 1.

Table 1: MICT SETA ICT skills shortage figures published in 2011

Career/job description	Shortage (registered vacancies within ICT industry and other industries)
Business analyst	299
Systems analyst	362
Web developer	51
Analyst programmer	52
Software developer / programmer / engineer	572
Security specialist	63
Systems administrator	175

What is interesting to note is the absence of mobile application development in this list of scarce skills. A detailed critique of the MICT SETA data and other similar publications, which includes a discussion regarding the dated and incomplete nature of MICT SETA data, is available in the literature (Lotriet, Matthee, & Alexander, 2010). An analysis and critique of this data can be found in Part 2 of this text.

Cremer (2011) provides a comprehensive summary of the MICT SETA data (MICT-SETA, 2011) and compares it to a summarised list of scarce ICT skills in South Africa constructed by measuring the number of industry vacancies for ICT skills. Mobile application development, a skills set receiving detailed attention in Part 3 of this study, is added to the list of scarce IS skills, joining business and systems analysis and software development (various languages) at the top of the core ICT industry's list of skills needs. Mobile application development, as seen later in this study (Part 3), deserves its place on this list and provides IS departments with an opportunity to regain lost ground in meeting industry skills needs.

1.7 Core ICT labour and ICT labour within the creative industries

As this study progressed, it became clear that it would not be possible to address the South African IS labour shortage simply by increasing the number of IS graduates – the industry readiness of these students had to be increased as well. Do the skills of the average IS graduate match the skills needed by industry? This question necessitated a look at definitions of the ICT industry [the workplace of

many IS graduates], a breakdown of ICT sectors [including sectors that use IS professionals], and different types of ICT labour (occupations, including but not limited to IS occupations) within each sector, and the need for each of these occupations.

The researcher returns to the concept of matching ICT labour supply (graduates) with labour demand (the need for labourers in specific occupations) in Part 2 and Part 3 of this study. The definition of ICT labour and non-ICT labour requires descriptive attention first.

Sabadash (2012) provides a comprehensive definition of the ICT industry and sectors, and a detailed, standardised ICT occupation taxonomy. Based on Eurostat National Account data, Sabadash (2012) presents a definition of the ICT industry by listing and grouping together industry sectors that can be classified as ICT sectors (see Figure 2). Refer to Figure 3 for an extract from the standardised occupation taxonomy[5].

ICT manufacturing industries

26	Manufacture of computer, electronic and optical equipment
2610	Manufacture of electronic components and boards
2620	Manufacture of computers and peripheral equipment
2630	Manufacture of communication equipment
2640	Manufacture of consumer electronics
2680	Manufacture of magnetic and optical media

ICT trade industries

4651	Wholesale of computers, computer peripheral equipment and software
4652	Wholesale of electronic and telecommunications equipment and parts

ICT services industries

5820	Software publishing
61	Telecommunications
6110	Wired telecommunications activities
6120	Wireless telecommunications activities
6130	Satellite telecommunications activities
6190	Other telecommunications activities
62-63	Computer programming, consulting and information service activities
6201	Computer programming activities
6202	Computer consultancy and computer facilities management activities
6209	Other information technology and computer service activities
631	Data processing, hosting and related activities, and web portals
6311	Data processing, hosting and related activities
6312	Web portals
95	Repair of computers and personal and household goods
951	Repair of computers and communication equipment
9511	Repair of computers and peripheral equipment
9512	Repair of communication equipment

Figure 2: ICT industry sectors (Sabadash, 2012)

[5] The complete occupation taxonomy is too long to include in this document. It is available in Sabadash (2012).

251 **Software and multimedia developers and analysts**
2511 Systems analysts
2512 Software developers
2513 Web and multimedia developers
2519 Software and multimedia developers and analysts not elsewhere classified
252 **Database specialists and systems administrators**
2521 Database designers and administrators
2522 Systems administrators
253 **ICT network and hardware professionals**
2531 Computer network professionals
2532 Telecommunications engineering professionals
2529 ICT network and hardware professionals not elsewhere classified

Figure 3: Extract from ICT occupation taxonomy (Sabadash, 2012)

These definitions are used, especially the IS occupations listed in this definition, when referring to core ICT or core IS labour [occupations] in this thesis. This definition of ICT labour (Sabadash, 2012) is used primarily in Part 2 of this study, which focuses mainly on the [graduate] supply of core (technical) IS skills and the jobs available in the mainstream IS industry – business analysis, systems analysis, data modelling, data administration, and software development. The only career (ICT labour group) analysed in Part 2 that is not a traditional IS speciality, and is not clearly defined in ICT occupation taxonomies in the literature (Sabadash, 2012), is mobile application development, although this can be seen as part of software development. The reason for including the mobile application development skill set in the definition of ICT labour in Part 2 is that it creates a connection point with non-core ICT/IS career groups – the subject of our discussion in Part 3.

In Part 3, frequent mention is made of embedded ICT labour (which, of course, includes embedded IS labour). What is embedded ICT labour? It is ICT labour that works outside the core (technical) ICT industry, as defined by Sabadash (2012). This labour includes IS graduates (professionals) working for media firms, marketing firms, advertising agencies, entertainment and film companies, design houses, and new media ventures. These non-ICT industries that make use of ICT labour form part of a larger classification of industries called the creative industries, as explained by Flew (2011).

Therefore, when the researcher addresses the employability of IS students, we need to consider their readiness to enter into core IS occupations and non-core IS careers within the creative industries. Creative industry readiness becomes even more important when we consider that these industries are outperforming traditional economic sectors during difficult economic times (Flew, 2011).

In short, Part 2 focuses on core IS labour. which includes mobile application development; Part 3 focuses on both core IS and embedded IS labour, and the framework we suggest in Part 4 – the IS Graduate Development Framework (ISGDF) – follows a more comprehensive approach and applies to both classifications of IS labour.

1.8 The concept of student capability

As part of his capability approach to welfare economics, Sen (1985, 1999) mentions individual differences in the ability to transform resources into valuable activities as an important consideration when measuring an individual's capability. In a more recent publication, Sen (2009) again mentions – as part of an argument that suggests the capability approach as fundamental to the theory of justice – the ability of individuals to create individual freedoms (being able to do things the individual deems important) through the transformation of available resources.

This capability approach (theory) is summarised and applied to education contexts by Walker (2005). Zheng (2007) suggests a research agenda that will inform e-development initiatives with an understanding of the capability approach. Zheng (2007, p. 3) provides the following diagram and explanation as a summary of the capability approach (as illustrated in Figure 4):

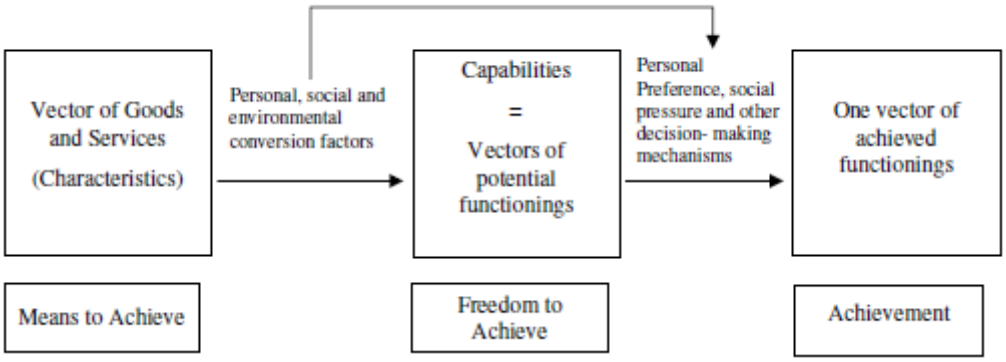


Figure 4: Representation of core aspects of the Capability Approach

> *Goods and services being the means to achieve (a life that one values), a person's freedom to achieve is defined by the capabilities, namely, potential functionings, that she is endowed with, including what her individual conversion factors allow her to generate from the available goods and services. It should be noted that not all capabilities have to be generated from goods or services* (Zheng, 2007, p. 3).

This theory – stating that some individuals or groups do better than others in development scenarios (generate more individual freedoms for themselves and others) given the same amount of resources (access to goods and services) – is adopted as a foundational assumption for this study. While a

detailed discussion of capability theory is beyond the scope of this text (see Walker, 2005), we note that this assumption of its correctness informs this study with two axioms from welfare economics theory:

1) A person's (or group's) ability to excel in a development scenario is related to personal character and aptitude.

2) A person's (or group's) ability to excel in a development scenario is related to his/her position of freedom (including social and financial freedom).

Several groups of students were interviewed, observed and educated throughout this study. The two abovementioned truisms did not only influence the nature of these data gathering and development activities directly, but led the researcher away from the popular South African philosophy of blaming current socio-economic challenges (including the shortage of e-skills) on the country's political history. This is a philosophy often voiced in the e-skills (shortage) debate, and it has become a point of rhetoric closure[6] in the greater digital divide debate.

To prevent this study from ending with the same conclusion – South Africa is struggling to develop e-skills at a tertiary level due to the country's political history and will hence only catch up with first world countries in the e-skills race when the effects of this political history have somehow been rectified – the researcher sets guidelines in place to aid education-focussed development endeavours and data-gathering activities. These guidelines are as follows:

1) Measures and findings must, where possible, include reference to the personal characteristics and aptitude of the research subjects (students).

2) Measures and findings must, where possible, include reference to the position of freedom of the research subjects (this may include sensitively considered references to political history).

3) Measures and findings must, where possible, take into account that students from the same position of freedom will develop at different rates given the same resources and freedom of choice.

4) The philosophy of this study must stay clean of premature assumptions regarding the importance (or lack of importance) of the research subjects' historical background, and

[6] Rhetoric closure, as discussed by Habermas (1984) in his work on the social theory of communicative action.

rather combine political/historical variables with other position-of-freedom variables such as access to education, access to computers, and access to information about IS as a career option.

An example of how these guidelines were used throughout the study is in order. As shown in Part 2 of this study, students from schools classified as being in previously disadvantaged communities now often have the same level of access to computers, the internet and tertiary education opportunities as students from previously advantaged schools. This finding is an example of how the abovementioned guidelines were applied, as they led the researcher on a search for other significant variables to explain why students from these schools chose (or did not choose) IS/IT as a field of study – variables such as access to information about IS career opportunities and cultural beliefs about technology-focussed careers. The assumption of the capability approach and the resultant research guidelines helped the researcher to stay away from (flawed) conclusions such as "these [previously disadvantaged] students do not have access to computers or good computer teachers due to the political history of their area". In many cases, a focus on the capabilities of individuals within a given development environment and the given restrictions on resources led to observations that students from so-called previously disadvantaged communities proved a more dependable choice as potential IS students than students from previously advantaged areas. These findings are discussed in Part 2.

With the given background information borne in mind, and the introductory notes to this thesis now complete, a description of the structure of this document and the research questions of this study are provided next.

1.9 The structure of this thesis

This thesis was designed following the research dissertation guidelines of Mouton (Mouton, 2001), and consists of nine chapters: introduction, literature review, methodology and research design, five results chapters (four in article form, and one describing practical implementation), and a conclusion.

The results section of this text has been divided into four complementary parts. The first part, Part 1, relates to the first research question and focuses on the nature of existing development projects that aim to solve the mentioned IS skills shortage and ways of accelerating these projects towards sustainability. This first part of the thesis is provided in article format, as it was successfully

submitted for publication in this format. The article is enriched by an introduction and end notes that position it clearly within the main argument of this study.

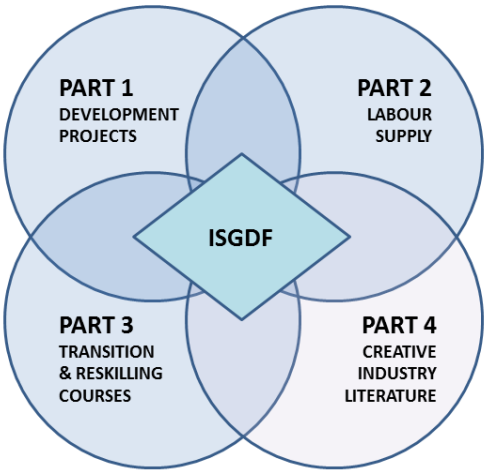


Figure 5: Visual presentation of thesis structure

The second part of the study, Part 2, focuses on the second research question and provides a detailed analysis of the supply and demand of ICT skills in South Africa, with IS skills receiving primary focus. IS graduate supply is seen as the product of a supply chain – similar approaches are described in the literature (Calitz, 2011). A large-scale survey of thousands of first-year tertiary students interrogates variables that influence the supply chain of IS students (potential graduates), as well as the price elasticity of the resulting graduate supply. The findings from this section of the study help to bind the main argument of the study together, placed between Part 1 and Part 3, as it relates both to (i) the nature of projects that can have a positive effect on IS graduate supply (this echoes findings from Part 1), and (ii) the specific education-focussed variables that can be used as handles by IS departments to redirect their student supply towards industry needs (this relates to findings from Part 3). This chapter is also presented as an article, as it was successfully presented in this format as conference proceedings.

The third part of this study, Part 3, shares what the researcher believes to be a contextually [and philosophically] sensitive solution to the IS skills shortage in South Africa, informed by the research outcomes of Part 1 and Part 2, and tested in two different development settings described as two case studies. The solution takes form as transition and reskilling short courses focussed on scarce IS skills, with mobile application development and related entrepreneurial skills taking centre stage. This part of the study is presented in the article format in which it was submitted for publication.

The fourth and final part of this study, Part 4, combines the findings from the previous three parts into a comprehensive IS Graduate Development Framework (ISGDF) that suggests ways of increasing the quality and quantity of tertiary-level IS students, while increasing the employability (industry readiness) and level of entrepreneurial potential of IS graduates. This part of the study also includes a detailed description of how the framework was used in practice and the lessons learnt from this measuring activity. The results from the initial usage of the framework guided the development of a mobile application that facilitates some of the key success factors [of IS graduate development projects] suggested by the framework.

As this chapter of the thesis serves as a summary of the document, a short summary of each of the four main parts of this study is provided below.

1.9.1 Part 1 – The nature, maturity, and sustainability of ICT development projects

As a logical starting point for this study, the researcher studied existing development projects that aim to increase the quantity and/or quality of secondary school students who qualify for tertiary schooling in IS [and related technical fields of study]. The researcher also assisted in the launch of a medium-scale development project – the Computer Redistribution Project – at two universities in South Africa, and gained valuable insights into the character of development projects through this hands-on experience. The primary research focus in this part of the study was finding ways of [variables that stimulate towards] accelerating existing development projects [including IS education-focussed development] towards sustainability. The findings of this part of the study include guidelines for maturing development projects towards sustainability, such as (i) the importance of nurturing diffused increases in development potential and (ii) the importance of social recognition and the celebration of achievement in gaining momentum towards sustainable development. The findings from Part 1 are used as foundational assumptions for the researcher's argument in Part 2 of this study.

1.9.2 Part 2 – The supply, and supply elasticity, of IS graduates

With a firm grounding in IS development theory [established earlier in Part 1], Part 2 takes a look at the core issue behind this study – the reported shortage of IS graduates in South Africa.

Presenting IS skills shortage data using labour market supply and demand curves provides another angle of approach to this data and an opportunity to validate the existence of a skills shortage (if it

exists), as well as reasons for such a shortage. This neoclassical labour market view of the South African ICT skills deficiency is enriched by a discussion of the elasticity of supply within the South African ICT labour market. The findings of this section of the study include the tendency of an increase in scarce labour supply to trigger further increases in demand for such skills through an increase in capital investments within the scarce skills sectors, causing a yearly supply shortage to remain until capital investments reach a profit-maximising equilibrium.

In the latter sections of Part 2, variables are investigated that influence the elasticity of supply within the ICT labour market using a large-scale survey of tertiary students. Ways of (i) increasing the elasticity of ICT graduate supply and (ii) increasing the overall ICT graduate supply level through the manipulation of these variables are discussed. Findings include, amongst others, the importance of long-term relationships (with well-informed parents and teachers) as primary motivator for tertiary ICT study and the importance of industry-informed (demand-driven) ICT-related subjects at secondary school level as motivation for tertiary ICT study. The match between ICT skills being supplied and demanded also receives mention as part of this conceptual ICT labour market analysis.

1.9.3 Part 3 – Putting a solution to work

In this part of the study, all the suggestions gained in Part 1 and Part 2 are combined into a practical solution to the South African IS skills shortage dilemma – a real-time test of the suggestions made in the framework that follows in Part 4.

Moving towards answering the research question(s) of this study, Part 3 describes ways of stimulating the needed growth in the quality and quantity of IS graduates who are suitably skilled to take part in core IS industries and the emerging creative industries in South Africa. This growth is achieved **through short courses focussed on innovation and entrepreneurship within the mobile application development domain.**

This article presents two case studies describing how mobile application development short courses, as examples of successful IS education projects in South Africa that impact core IS and creative industries, can be used to (i) stimulate growth in the overall industry-ready IS graduate supply in South Africa, and (ii) grow the entrepreneurial potential within the IS labour supply.

The researcher's conceptual solution is put into practice, and initial data is discussed. This implementation takes the form of two long-term projects, supported by two local universities, that guide high school (secondary grade school) students and non-ICT graduates towards a long-term

(career-focussed) interest in information systems through exposure to mobile information systems/ application development.

1.9.4 Part 4 – Contribution: IS Graduate Development Framework

This study concludes on a positive note, with a contribution towards counteracting the growing IS skills shortage in South Africa. The development work done during the four-year duration of this research will continue through the use of the proposed IS Graduate Development Framework.

This framework combines the measurable variables from the previous three parts of the study – twenty variables in total – into a twenty-point framework for measuring the graduate development potential of any IS education project or IS graduate syllabus. Using the framework, suggestions are made for how projects and syllabi can be adjusted [improved] so that graduate supply can be increased after using the suggested evaluative framework.

Each of the four parts of this thesis are presented in article form, and hence include an introduction, a literature review and a description of the research question pertaining to that part of the study. Each part will also include an outline of the methodology and philosophy used to approach the research question of that part. The concluding part of this thesis, Part 4, serves a dual purpose: (1) a description of the researcher's solution to the IS shortage being put into practice at a leading South African university in the form of short courses that have been informed by the IS Graduate Development Framework, and (2) a chapter that combines the findings of Part 1, Part 2 and Part 3 into a coherent addition [contribution] to the body of knowledge on IS development.

1.9.5 Argument drawings

The reader will find a visual outline of the argumant at the start of each new section of this text. These argument outlines, or roadmaps, will assist the reader in navigating his/her way through the complex e-skills discourse and the researcher's proposed solution to the research question(s) of this study. See Figure 1 as an example of these visual guides that will introduce each section of the text.

1.10 Research questions

The primary research question of this study relates to solving the IS skills shortage problem in South Africa, particularly the deficiency of tertiary (graduate)-level IS skills. The research question is stated as follows:

How can the quality and quantity of tertiary enrolments and graduates in IS [and IS-related] studies be increased?

This research question was approached in four sections, Part 1, 2, 3 and 4 of this thesis, as described above. Each of these sections investigates a different part of the primary research question, as follows:

- **Part 1:** Why are current ICT infrastructure development and IS education development projects not producing the required results? Can these existing projects be accelerated towards sustainability?

- **Part 2:** What is the nature of the current IS graduate supply and demand? Does the human capital approach to labour supply give us any new insights into the existing IS graduate supply shortage? Why are so few students (and so few good students) choosing IS or IT as study field or career choice (hence choosing to become part of the IS graduate supply chain)?

- **Part 3:** Can short IS transition and reskilling courses be implemented as sustainable projects that will assist a typical IS department to increase the quality and quantity of first-year enrolments and the quantity and employability of final-year graduates? Were these projects successful?

- **Part 4:** Can the research findings of this study be combined into a framework that will assist IS departments to increase the quality and quantity of their enrolments and graduates, thus answering the primary research question of this study

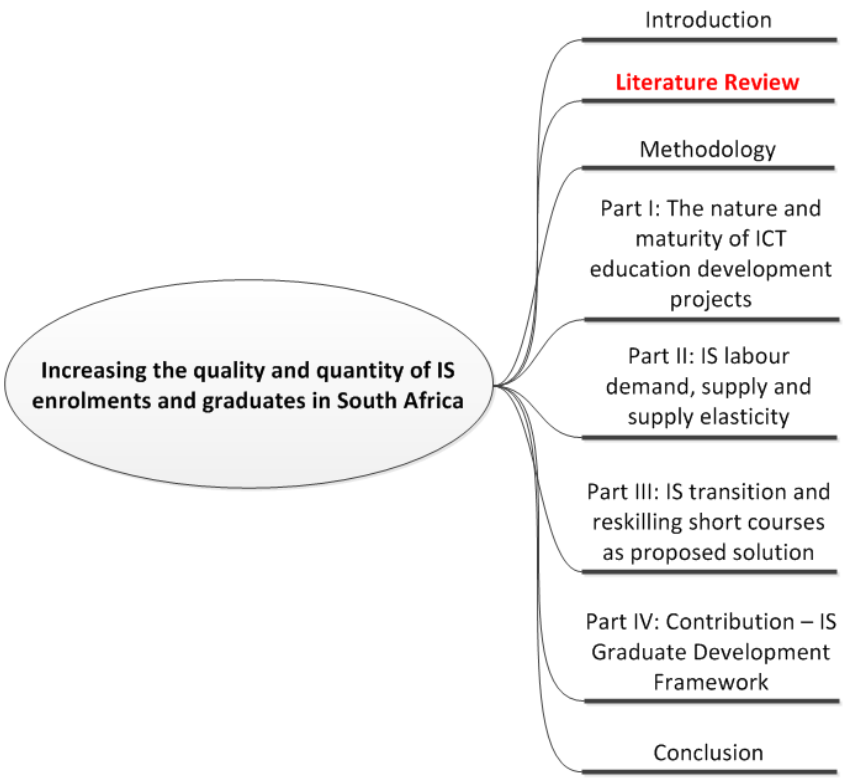
1.11 Conclusion

In this introduction to the thesis, the researcher provided a summary of relevant background information concerning the main argument of the study, notes on the research philosophy and the ICT4D point of departure of this study, a brief depiction of the South African IS skills shortage as problem domain, the structure of this text, and a breakdown of the primary research question into subordinate questions.

In the next chapter, Chapter 2, the researcher presents an overview of literature that influenced this study. After this literature review, the research methodology followed in each of the four primary parts of this thesis is discussed in Chapter 3. The literature review and methodology overview, together with the methodology notes included within each of the four primary parts of the text,

should present the reader with a clear view of exactly *how* the researcher approached the research question and its resultant secondary questions.

CHAPTER 2: PRELIMINARY LITERATURE REVIEW



This chapter presents a summary of the literature that informed this thesis. This literature review starts with a broad placement of the research topic within the body of IS knowledge, after which the chapter narrows down, focussing on themes that are closely related to the research questions at hand. Some themes are discussed only briefly, as these concepts are sufficiently expanded on in the four results chapters of this thesis.

This chapter is structured as follows. First, IS research considerations regarding the chosen topic and research paradigm are discussed. Second, the review stays within the broad domain of IS theory and presents a summary of social theory that had an impact on this IS study. Third, moving closer to the research topic, a discussion of literature pertaining to development projects in the ICT4D and information systems for developing countries (ISDC) research fields is provided. The chapter ends with an overview of theory that is closely related to the topic of this study – IS graduate development. This final section is divided into three subsections: (i) IS labour supply literature, (ii) IS education literature, and (iii) creative industry labour literature.

2.1 IS research considerations

The research paradigm chosen for a study has an impact on the design and implementation of the research activities. This study may be classified as critical IS research. Presenting this study as critical IS research necessitates a literature-based understanding of what critical IS research is, and why it was chosen as research paradigm for this study.

The researcher agrees with recent publications (Cecez-Kecmanovic, Klein, & Brooke, 2008; Walsham, 2005) that critical IS research continues to change in nature, but that it can be defined broadly as a set of characteristics, as follows:

> *critical [IS] research typically (1) is engaging 'with questions that are of an overtly political or moral nature'; (2) is driven by the motivation 'to focus on what is wrong with the world rather than what is right'; (3) requires the choice of an appropriate theory; and (4) has the intent to influence others* (Cecez-Kecmanovic *et al*., 2008, p. 8)

The vagueness of this definition of critical IS research underlines the difficulty authors have with delineating this paradigm. Recently our understanding of critical IS research was [significantly] clarified with the publication of a set of six principles for conducting critical IS research (Myers & Klein, 2011). These principles are (i) the principle of using core concepts from critical social theorists, (ii) the principle of taking a value position, (iii) the principle of revealing and challenging prevailing beliefs and social practices, (iv) the principle of individual emancipation, (v) the principle of

improvements in society, and (vi) the principle of improvements in social theories (Myers & Klein, 2011). This research study is sensitive to these guidelines for critical IS research throughout.

The fourth principle mentioned above, the concept of individual emancipation within critical research, requires further attention, as this study is founded upon the concept of development as an increase in freedom (Sen, 1999) – with increases in freedom [and equality] being at the heart of emancipatory research. From the definitions in the extant literature (Lyytinen & Hirschheim, 1988; Myers & Klein, 2011; Myers & Young 1997; Klein, 1994; Pozzebon *et al*., 2006), critical IS research can be defined as emancipatory IS research that questions motives behind validity claims, thereby exposing false assumptions made during research or practice by focussing on subversive themes of power, control, resistance, inequality, justice and freedom. In the information systems field, this type of research is steadily growing in popularity (Klein & Myers, 1999; Trauth & Howcraft, 2006). This growth could be accredited to authors such as Orlikowski and Baroudi (1991), who focussed the attention of the IS research community on the severe lack of critical research within the IS field. The popularity of the critical [emancipatory] research paradigm in development-oriented IS research can also be ascribed to the growth in the body of knowledge [literature] that links emancipatory themes such as justice and equality to economic development discourses (Sen, 1999; 2009).

This thesis contains several critical emancipatory notes regarding underlying assumptions and validity claims within the IS skills shortage discourse. These assumptions and validity claims include (a) the importance of social variables in ICT4D project success, (b) the importance of access to ICT infrastructure as a variable influencing graduate development, (c) the existence (and nature) of the skills shortage and the skills shortage being an indicator of non-competitive conditions within the IS labour market, and (d) education-driven IS graduate development projects as drivers of economic growth. These assumptions, and others, are reviewed critically in the chapters to follow, following the guidelines set out by Myers and Klein (2011). The framework presented as part of the contribution of this thesis – the IS Graduate Development Framework – was informed by this sensitivity for these underlying validity claims.

The fifth principle of critical IS research, being concerned with improvements within societies (Myers & Klein, 2011), supports the use of social theories [and the measurement of social variables] as theoretical grounds in critical IS research studies. Jones and Karsten (2008) provide clear guidelines for how social theories should be used sensibly within emancipatory IS research, using structuration theory (Giddens, 1984) as example. Practical examples of IS research informed by social variables are

available in the literature (Córdoba & Midgley, 2008). In the next section of this review, an account of social theories is given that helped shape the research design of this study.

Research done as part of the education development discourse in the IS field is often interpretive [interpretivist] in nature, as opposed to being positivist. Hirschheim and Klein (1989) and Walsham (2006) provide guidelines for interpretive IS research, which are adhered to in this study. Walsham (2006) discusses interpretive case study work, which relates well to the methodology followed in Part 1 and Part 3 of this research. The IS research is mostly interpretive, with the possible exception of Part 2. The topics related to being concerned with IS graduate development through education-driven development projects lend themselves well to interpretive research. Role players are interviewed and observed within local contexts, with the researcher forming part of the context. Many of these interpretive IS research studies (see Part 1, Part 3 and Parkinson (2005) as African examples) are also critical in nature – sensitive to underlying social themes, with emancipatory motives. With the abovementioned definitions in mind, this thesis can best be described as being a critical interpretive research study. This research approach fits within IS development literature, with several other studies following a similar approach (Hartley, McWilliam, Burgess, & Banks, 2008; Kanungo, 2004; Krauss, 2010; Krauss & Turpin, 2010; Snyder, 2007; Waring, 1999). Note how the referenced authors use an interpretive approach to analysing case studies, while being critically attuned to underlying assumptions regarding IS education and IS development problems – similar to the approach used in this thesis. The understanding of critical emancipatory research was further informed by literature discussing [or using] this research paradigm outside IS, especially readings in the field of disability studies (McColl, Adair, Davey, & Kates, 2013; Oliver, 1997).

As an expounding note regarding the research paradigm of this study, it is confirmed that a research study can be both critical and interpretive in nature – the two paradigms overlap in a way that suggests a blended critical-interpretive approach. This approach is popular within social research, with examples spanning thirty years of literature (Deetz, 1982).

In this section, literature pertaining to the choice of research paradigm was discussed. Social theories that informed this study will be discussed in the next section.

2.2 Social theory

One of the principles for conducting critical IS research (Myers & Klein, 2011) is the principle of using core concepts from critical social theorists. In this section the works of social theorists that influenced this thesis are discussed, some directly, and some on an indirect, motivational level.

2.2.1 Communicative action

From Habermas (1984), the critical IS researcher learns that her/his work can, and should, delve deeper into the motivations behind actions involving technological artefacts. As suggested in the previous section, validity claims [assumptions] behind IS research findings can and should be questioned. As an example, with reference to the topic of this thesis, a valid question to ask within the IS skills shortage discourse would be, "does a measurable IS skills shortage exist?" (Lotriet *et al*., 2010). Other assumptions within this debate [that should be tested] include the assumption of disadvantage related to lower levels of IS innovation in non-Western countries, as highlighted by Avgerou (2009, p. 15):

> *…an assumption permeating most ISDC research is that developing countries are in disadvantage in relation to the IS innovation experiences in the context of the origin of new technologies and related new organizational models.*

The influence of social structures of control (political structures, hidden agendas, etc.) on IS research findings should be investigated (Avgerou, 2009; Myers & Young, 1997). Insights gained through such investigations can put existing IS findings in a new light, and can pre-empt immature rhetorical closure in [development oriented] IS debates (Pozzebon *et al.*, 2006).

This study is influenced by Habermas's call for critical review within communicative action in two ways:

- validating, and encouraging, discursive action within the IS community regarding assumptions related to IS graduate development
- providing IS researchers with a theoretical framework within which to place emancipatory communicative action – communication concerned with the role of IS in social justice and economic welfare discourses. Although communicative action theory is not applied directly as a framework in this thesis, the critical emancipatory character of this thesis has been informed, and in a sense validated, by this theory.

Research within the IS development discourse has been influenced strongly by western concepts of development, as the majority of prevailing IS development concepts were conceived within a western context. At the outset of this critical IS research study, which investigates development themes, it is noted that this western development influence has led to fundamentally invalid western assumptions prevailing within uniquely South African streams of communicative action, such as the IS skills shortage discourse.

> *The context where a new technology artefact and business model first took shape (usually in an advanced economy) may be different from the context where this combined artefact and model are implemented as part of IS innovation practice in a developing country* (Avgerou, 2009, p. 15)

Two decades previously, Escobar (1992) argued that the western concept of development has run its course, and that the destruction it had left in its wake, both epistemologically and politically, was finally leading to the disillusionment of "developing countries". These countries were starting to understand the damaging effects of adopting invalid assumptions made within the western development discourse and were responding with what Escobar termed "local grassroots initiatives" (Escobar, 1992). In more recent literature, this "grassroots initiatives" concept is translated as "by the community, for the community" (Coetzee, 2010; Part 1). These are development initiatives that are managed by local communities, focusing on local socio-economic problems – including skills gaps within local labour markets. Twenty years after the work of Escobar (1992), the value of its findings within our own information systems for developing countries (ISDC) context is understood.

Sen (1999) argues that the western development discourse wrongly places the focus of developmental actions on increasing the financial wealth of societies. This creates a disconnect between rich investor and poor investee. Of practical importance to this study, this disconnect results in IS development projects that are too dependent on donor funding – this is discussed in Part 1. According to Sen (1999), development initiatives should focus on increasing the *well-being,* or *freedoms*, of a person or society. To do this, investors must rid themselves of western concepts such as optimising return on investment or increasing utility – two popular economic points of departure within the development discourse. Well-being is a more complex formula than the one proposed by western development, and changes according to the political and epistemological ways of thinking prevalent in the developing society.

2.2.2 Structuration theory

In Part 1 of this thesis, the researcher makes use of fundamental concepts from Giddens's structuration theory (Giddens, 1984). Of primary concern in Part 1 is the concept that a society is the result of its actions and continuously redefines itself by choosing to act and react in certain ways (Giddens, 1984). Communities gain momentum in a certain activity [project] by continuously choosing to perform, again and again, that activity in a certain way. It is not enough for a community to work towards having greater economic freedom, or social freedom, or political freedom (types of freedom are defined in Part 1, based on Sen, 1999), or any other goal of ICT4D projects, by performing a once-off rearrangement of social structures. The newly identified development possibilities of ICT4D projects must be acted upon, and acted upon continuously.

The researcher does not want to oversell the usage of structuration theory in this text. He is sensitive to the suggestions made by Jones and Karsten (2008) regarding the use of Giddens within IS research, and notes that this study might be critiqued as "making narrow use of structuration theory" (Jones & Karsten, 2008). The use and application of structuration theory during the creation of a socially sensitive development project maturity model in Part 1 is indicated. The researcher makes use of structuration theory and communicative action theory (discussed in the previous section) for the purposes of explanation, as defined by Gregor (2006) in her taxonomy of IS theory. Even though these theories can be used to influence the analysis, prediction, and design and creation of information systems, they are not used as such. These theories are but the explanatory foundation for the critique of IS graduate development projects and their effects on community members.

Having discussed the social theories that afforded the researcher a handle on social variables that influence IS graduate development, we now move a step closer to the target (IS graduate development) by discussing the success and failure of development projects that influence graduate numbers and quality. The success [or failure] of these projects, it turns out, can often be traced back to social variables (refer to the findings in Part 1).

2.3 ICT for development projects

In this section, the literature review of the research topic is narrowed down. When doing critical IS research that involves concepts of development, the researcher was confronted with the broad [underlying] assumption that there is a link between ICT development and economic growth (Avgerou, 2003, 2009; Avgerou & Cornford, 1998). It is this assumed link between technology and

economics – the economically enabling power of ICT and IS – that fuels growth within the information systems for developing countries (ISDC) research field (Walsham, Robey, & Sahay, 2007), and political interest in IS graduate development.

The relationship between investment in ICT development projects and human development variables such as gross domestic product and education (number of enrolments) has received recent attention within the South African [and African] context (Bankole, Shirazi, & Brown, 2011), and the broader developing countries context (Ngwenyama & Morawczynski, 2009).

This thesis begins, in Part 1, with a critical investigation of this link between ICT development and economic growth by looking at the maturity of community-based ICT development projects, and why so few of these projects result in [the promised] economic growth. The mentioned potential economic benefits of successful ICT development projects are used as a motivation for this study. Warnings within the literature, that the economic growth that results from ICT4D projects is contextual, are acknowledged – the same results cannot be guaranteed elsewhere (Avgerou, 2009). It is also acknowledged that the relationship between ICT development and economic well-being differs in high-income, middle-income and low-income communities (Bankole *et al.*, 2011). The focus is consequently moved away from the formulation of an IS development recipe for economic growth, and rather is on social variables that influence project maturity. Project maturity, per definition, will result in sustained development outputs. The focus thus was not on economic growth as such, but rather on tangible results of development actions (measurable increases in freedom), which in turn *may* result in economic growth.

In the following subsection, the attention is turned to the notion of development project maturity.

2.3.1 ICT for development maturity variables

ICT4D and ISDC education and infrastructure projects that aim at graduate development (the primary topic of this thesis) often fail to reach a level of maturity that ensures sustainability before donor funding is withdrawn [or depleted]. Using an alternative definition of development, as increases in freedom (Sen, 1999) – relating to Sen's capability approach (Andersson *et al.*, 2012; Walker, 2005), and an existing IT project maturity model (Leem, Kim, Yu, & Paek, 2008), the researcher investigates the level of project maturity needed to ensure project sustainability, and the social variables that influence this maturity (Part 1). Social variables that have a strong influence on projects aimed at graduate development are (i) local ownership of projects (Avgerou, 2009; Coetzee, 2010; Heeks, 2008), (ii) the level of social embeddedness of projects (Avgerou, 2000; Pade-Khene,

Mallinson, & Sewry, 2011), epistemologically based on the work of Giddens (1984), as discussed earlier, (iii) the role of the media and social recognition (celebration) in project success (Chigona & Mooketsi, 2011), and (iv) the importance of focusing on direct and diffused increases in freedom (Sen, 1999) during development projects. These social variables were deconstructed into practical measures, with secondary questions, and used to construct the first section of the IS Graduate Development Framework, discussed in the final results chapter of this thesis (Part 4).

The use of maturity models as tools for the measurement of the sustainability of projects within the ICT4D field is new within the literature (Part 1). The choice of maturity model, however, was informed by relevant IT project management literature. The researcher was looking for maturity models that would describe technical projects that could be enhanced to include social variables that influence the maturity of technical projects. Some promising maturity models (Karimi, Gupta, & Somers, 1996; Lee, Kim, Paulson, & Park, 2008) were found, but only one model used a maturity stage approach that could be related to Sen's concept of increasing freedom in stages with conceptual ease (Leem *et al.*, 2008; Sen, 1999). This model was adjusted and used as the resulting tool to support the critique of ICT4D projects that influence graduate numbers. Other technical-social frameworks were investigated as part of the process of adjusting Leem's model (Leem *et al.*, 2008) to meet the researcher's needs (Andersen, Henriksen, & Aarseth, 2006; Parasuraman & Grewal, 2000).

This concludes the overview of the literature discussing development projects that have an influence on IS graduate measures, be it through infrastructure development or education. This theme is expanded on in Part 1 of this thesis. Next, the literature supporting Part 2, Part 3, and Part 4 is discussed.

2.4 IS graduate development

In this section of the literature review, sources are discussed that are closely related to the research questions regarding the stimulation of IS graduate development as a possible solution to the IS skills shortage in South Africa. The discussion covers three veins of IS literature, namely (i) literature discussing IS labour supply and capacity building, (ii) IS education literature, and (iii) creative industry literature discussing labour and employment variables. An overview of these literature sources should give the reader a clear indication of the researcher's angles of approach to answering the stipulated research questions.

The researcher found significant variables that influence graduate development projects in three parallel streams of development-oriented IS literature, and accordingly presents a short overview of these variables in the following three sections of this literature review.

2.4.1 IS labour supply and capacity building variables

As was discussed briefly in the introduction to this thesis, the IS skills shortage addressed through this research study forms part of a greater e-skills deficiency discourse in South Africa, with the National e-Skills Plan of Action (NeSPA, 2010) confirming e-skills development as being high on the government's priority list. It is within this context that IS graduate development projects [programmes/courses/institutions] are investigated as a possible solution to the IS skills shortage in the country. Twinomurinzi (2012) confirms the importance of having e-skilling on the top-level national development agenda, and argues for the budget and scope of e-skilling initiatives to be increased.

An angle of approach to the topic of IS graduate development that has received some attention in recent literature is the view that solutions to labour shortage problems (such as the IS skills shortage) can be found by informing IS literature with economic theories that address labour market failure – with theories such as human capital theory and labour capacity building theory receiving frequent mention (Debay & Teklu, 2012; Ponelis, Matthee, Buckley, Kroeze, Venter, & Pretorius, 2012; Toner, 2011). This approach was used in Part 2 to assist in answering the second of the four research sub-questions regarding the current state of IS labour supply in South Africa and how students could be motivated to study IS.

Following this approach of informing IS with labour market theory, the researcher analysed the South African IS labour market situation from within the neo-classical labour market framework of supply and demand in Part 2 of this thesis[7] (Part 2). The conceptual idea of performing a supply-and-demand analysis of the IS labour market was alluded to in recent literature (Merkofer & Murphy, 2009). It became clear that there is an insufficient supply of IS graduates and that the existing supply is very price inelastic in nature (Part 2). IS labour supply in South Africa also seemed to reach a production possibility frontier well before meeting industry demand. These findings mean that the task of solving the IS skills shortage is more complex than simply increasing the number of students

[7] Published as part of the 5th Annual SIG GlobDev Proceedings; referenced as Breytenbach and De Villiers (2012) in results chapters.

(not an easy task in itself). The nature of the existing graduate supply needs to change to become a better "skills match" with the industry demand of the day. Graduates unable to find work in scarce skills sectors are symptomatic of graduate skills not matching industry demand (NPC, 2012). Underlying assumptions that presented themselves at this point in the study included (i) the notion that any increase in IS enrolments/graduates would be met with ample employment opportunities, (ii) the claim that the IS skills shortage was a symptom of a failing education supply chain as opposed to being [at least in part] an indication of IS industry growth through increased capital investments, and (iii) the assumption that an increase in the quantity of IS enrolments/graduates without an increase in the quality of enrolments/graduates would resolve the issue of the IS labour market prematurely reaching a production possibility frontier.

In Part 2 of this thesis it is endeavoured to determine how the abovementioned change in the nature of IS labour supply could be brought about using education in order to ensure a better skills match. The first task at hand was the construction of supply and demand curves using the available data (Cremer, 2011; ITWeb, 2011; MICT-SETA, 2011). Then, by means of a large-scale survey (of 4 475 students) and the construction of a graduate supply elasticity model through regression analysis (Part 2), education-based variables that influence this elasticity [the skills matching nature] of IS labour supply were identified. These variables were informed by similar parallel studies (Alexander, *et al*., 2011; Alexander & Twinomurinzi, 2012), which suggested personal interest, career expectations, knowledge of career choices, and self-efficacy as motivators of study major and career choices. When applied to projects that aim towards IS graduate development, the career choice/education variables found by the researcher that could influence the nature of IS labour supply were translated into (i) the project's focus on the industry readiness of students (Bridgstock, 2011; Flew, 2011), (ii) the project's ability to supply students with sufficient career and salary information (Calitz, 2011), (iii) the project's focus (or lack of focus) on scarce IS skills as subject matter (Cremer, 2011; MICT-SETA, 2011), (iv) and the project's ability to leverage key motivational factors to influence student career choices (Alexander *et al*., 2011; Walstrom, Schambach, Jones, & Crampton, 2008). It turns out that the nature of IS labour supply in South Africa can be influenced through education-based development projects, if these projects are designed to influence career choice variables in favour of choosing IS as a career [or study major]. Lee and Fang (2008) present an insightful study in which IS students' perceptions of the skills required to achieve employment after graduation are compared with the expectations of IS labour recruiters. The results of this comparison indicate the students' severe lack of knowledge regarding industry conditions and skills/salary expectations.

The variables discussed in this section are elaborated on in Part 2 of this thesis, and were used to construct the second section of the IS Graduate Development Framework in Part 4. Part 2 of this study prompted further research into the type of education-based IS development project that could be used to influence IS graduate supply. The literature supporting this part of the study is discussed in the next section.

2.4.2 IS education variables – syllabus, approach, and course structure

In this section the IS education variables suggested in the literature to influence IS graduate development projects are discussed.

Sen (2009) warns against the over-institutionalisation of development projects (not just IS projects) in favour of a more flexible approach called the realisation-based comparison approach. This distinction, as theoretical as it might sound, has far-reaching implications for education institutions wanting to increase the quality and quantity of their graduates, as discussed in Part 3. It speaks to the nature of education-based development projects, and explains how development potential (in this case, the ability to develop more high-quality graduates) can be lost by overburdening short-term solutions with institutional restrictions. In recent years, this call for a more adaptive [flexible] approach in education delivery and curriculum design has been echoed in the IS literature (Goode, Willis, Wolf, & Harris, 2007).

In Part 3 of this thesis, an argument based on the literature is presented for flexible short transition and reskilling courses as an education-based solution to the IS skills deficiency[8] (presented in Part 3). The researcher uses the term flexible [or adaptive] education in the same way as defined in the literature (Goode *et al*., 2007). Flexible education can be implemented (interpreted) in four ways:

1. through a range of teaching and learning strategies such as lectures with tutorials, independent study, discussion/seminar groups, debates, and ICT-based education;

2. by permitting alternative programme design by incorporating notions such as modularisation of the content and/or courses that would allow learners to devise a sequence that best suits their particular needs and to negotiate assessment strategies that best reflect their learning styles;

[8] Article unpublished at time of print; referenced in results chapters as Breytenbach and De Villiers (2013a).

3. building flexibility into organisational structures and policies through the use of devices such as summer schools, block programmes, immersion programmes, part-time evening programmes, distance learning, and mixed mode programmes; and

4. the provision of flexibility through the institution's administrative policies and procedures, such as open entry and exit (Goode *et al*., 2007).

Besides promoting flexibility in education approach, short transition and reskilling courses, it is argued in Part 3, should include a far more comprehensive coverage of entrepreneurial skills [techniques] and a focus on innovation within core ICT and creative industries (Araya & Peters, 2010; Bakhshi & McVittie, 2009; Bridgstock, 2011; Cunningham & Higgs, 2009; Flew, 2011).

Moving even closer to the primary research motive – increasing IS enrolments and graduates in quality and quantity – a review of the IS education literature that discusses the number and/or quality of IS enrolments now follows.

IS enrolments have been decreasing steadily for many years, with the situation being described as a crisis by many (Beise, Robbins, Kaiser, & Niederman, 2009; Granger, Dick, Jacobson, & Van Slyke, 2007). In Part 2 of this study, the researcher confirms the low percentage of students who choose to seek employment in IS and computer science in a large-scale survey of the researcher's own design (4 475 students). Granger *et al*. (2007) report less than 4% of all first-year students choosing IS or computer science as study preference. Beise *et al*. (2009) report on a panel discussion where online resources and a focussed marketing approach for IS departments were suggested as possible solutions to the challenge of diminishing IS enrolments. In a recent study (Choudhury, Lopes, & Arthur, 2010), early intervention strategies for increasing enrolment figures are suggested – suggestions that were used during the design of one of the case study projects discussed in Part 3. These suggestions include (i) spending dedicated time with secondary school students, in a summer school format, informing them about IT careers with the aim of convincing the students to choose to study IT at the tertiary level, (ii) convincing students that IT careers are rewarding and creative in nature, and (iii) facilitating discussion between secondary school learners and industry representatives.

The variables discussed in this section – project institutionalisation, flexibility of education approach, the short course nature of successful IS graduate development projects, a context of low IS enrolment numbers, the [lack of] coverage of entrepreneurial skills, and early intervention strategies for overcoming low enrolment numbers – were used to construct the third section of the IS Graduate Development Framework presented in the contributory chapters of this text.

Part 2 and Part 3 will allude to the reality that many IS graduates end up working in non-traditional IS industry sectors, with many of these sectors forming part of what is known as the creative industries. The definitions of core ICT labour, core IS labour and embedded labour within the creative industries were discussed in the introductory chapter of this text, using the ICT occupation taxonomy of Sabadash (2012) as a guide. The next section of this literature review presents relevant creative industry literature that influenced the research aimed towards increasing the employability (a quality measure) of IS graduates.

2.4.3 Creative industry and employment variables

In this section, the focus is on the literature that influenced the fourth and final section of the IS Graduate Development Framework. This part of the framework focuses on variables that relate to the ability of IS graduates to find employment in both the core IS industry – traditionally seen as including careers such as business analysis, systems analysis, systems architecture, data modelling, software development and mobile application development – as well as the creative industries.

The concept of a group of industries termed the creative industries has been thoroughly critiqued in the literature, but it has stood the test of time and the concept has recently been defined comprehensively in the literature (Flew, 2011). This group of industries includes design, mobile application development, game (software) development, and the use of technology within peripheral fields such as animation, film, architecture, and fashion design (Flew, 2011).

The framework presented in Part 4 of this thesis suggests that, if IS educators are to counteract the growing IS skills shortage in South Africa by increasing the quality and quantity of IS graduates, it is important that these IS students are ready to work in both the core IS fields and as embedded labour within creative industries that make use of IS skills. Variables that measure the success of IS graduate development projects towards this end include (i) whether or not a project has trans-disciplinary focus/application (Banks & Deuze, 2009; Hearn & Bridgstock, 2009; Kroeze, 2012), (ii) whether a project develops [scarce] skills that can be applied in both core IS and creative industry occupations (Bridgstock, 2011; Part 3), (iii) a project's sensitivity to the unique business and policy challenges within the creative industries – such as intellectual property and copyright laws (Flew, 2011; Stolarick, Mellander, & Florida, 2010), and (iv) whether a project results in measurable increases in the level of employability and/or entrepreneurial potential displayed by students (Caves, 2003; Flew, 2011; Part 3). Interesting to note is how IS development studies in South Africa (Kroeze,

2012) confirm recent findings in the Australian economy (Bridgstock, 2011; Hearn & Bridgstock, 2009) regarding the need for trans-disciplinarily skills sets within IS labour.

Creative industry literature makes frequent mention of the entrepreneurial and innovation-oriented skills needed to be successful as a labourer within the creative industry sectors mentioned above. In addition to receiving industry-matching scarce skills training, IS students must be taught how to be innovative, and how to understand project management and problem-solving techniques (Tan & Teo, 2009). IS students must be taught to apply their skills in trans-disciplinary contexts (Bridgstock , 2011), and non-technical students should be allowed to inform arts and commerce degrees with IS subjects (Lobo & Vowels, 2009). A local example of a project that educates non-ICT graduates in software development is discussed in Part 3 of this document.

2.5 Summary

The following themes from the IS literature were discussed in this chapter.

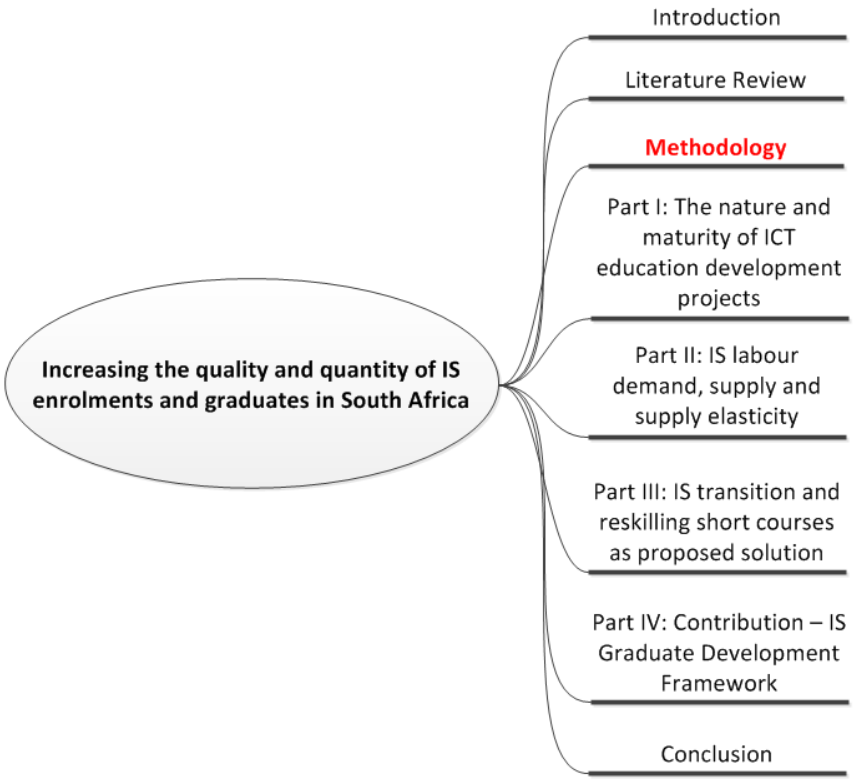
- Critical and interpretive IS research
- Social theories relevant to this study
- The nature and maturity of ICT4D projects that influence graduate development
- IS labour supply and capacity building in developing economies
- IS education variables that influence graduate development
- Creative industry literature and preparing IS graduates for a broader spectrum of occupations

The combination of these literature sources provides the researcher with a foundation on which to build a comprehensive framework for IS graduate development. The researcher approached the task of constructing this framework in four parts, presented as four articles in the four results chapters of this thesis.

This concludes the preliminary literature review for this study. Each of the four results chapters of this thesis, being presented in article format, ends with a list of references pertaining to the chapter in question.

In the next chapter, the methodology and research design of this thesis are presented.

CHAPTER 3: METHODOLOGY AND RESEARCH DESIGN



In this chapter the conceptualisation of the various parts of this study, issues of measurement, data collection and fieldwork practice, project workflow, data capturing and analysis, and some shortcomings and possible sources of error are discussed.

3.1 Introduction

Guided by the four sections of the primary research question, it was decided to present this thesis as four consecutive research studies. In the fourth part, Part 4, the findings from Part 1, Part 2 and Part 3 of this text are combined into a contribution that answers the primary research question of this study.

The four parts of this thesis are presented in article format. They were written as four consecutive articles that cover each of the four sections of the research question and, together, provide a well-rounded answer to the research question. This research design approach – breaking our argument up into four digestible parts – makes the main argument of the thesis easier to follow. The reader progresses logically [linearly] through the four parts of the text, reaching a logical conclusion in Part 4 in the form of a framework. This four-part argument, however, results in a thesis that contains several [seemingly disjointed] methodological approaches in consecutive chapters.

This chapter clarifies the methodological flow of the text by explaining the methodology followed for each of the four parts of the research and suggesting how each article ties in with the rest of the thesis. The methodology of each part of this study is divided into four sections – data gathering, workflow, data analysis, and a link to relevant appendices. Before looking at the methodology of each part of the study, some observations about the methodological character of this study are made.

A defining characteristic of this study is the large amount of practical development work that was conducted in an action research fashion by the researcher for the duration of the study. If we put the research value (data gathered, etc.) of these development projects aside for a moment and inspect the footprint of this study – the impact it has had on hundreds of participants in a number of communities – signs of direct and diffused increases in freedom are evident, which lead to the conclusion that the methodologies followed throughout this study have resulted in the realisation of a significant amount of development potential. Part 1 of this study saw the start of the Computer Redistribution Project, an infrastructure development project that redistributed second-hand computers (that were preloaded with large amounts of academic content) to academically promising students in the catchment areas of local universities. In Part 3, the researcher created two mobile

application development short courses (including the academic content) and presented these courses to two very different groups of promising students. In 2013, these courses, focussed on BlackBerry and Android mobile application development, will be running for a second year at two local universities, both with increased application numbers [after a successful first year]. The researcher mentions the practical success and impact of these projects here, before the reader perchance views them as short-term academic experiments.

Another defining characteristic of this study is its use of models. In Part 1, an existing software implementation maturity model was adjusted to become a maturity model for ICT4D development projects. The result of these actions is a very useful ICT4D maturity model – one of the first to incorporate important social variables associated with ICT4D projects. In Part 2, a ten-variable model that predicts the possibility of students choosing IS or IT as a career choice was developed. Although this model is not the primary output of Part 2 [Part 2 results primarily in a new understanding of IS labour supply and demand, informed by human capital theory, that suggests an education-based approach to increasing the elasticity of IS labour supply], it is still a very useful secondary output that can be used to sharpen the marketing approaches of IS departments. In Part 3, two mobile application development short courses were presented as models of the type of IS education-based project that can increase the quality and quantity of IS graduates and enrolments countrywide. Again it is important to note that, in all three sections, the researcher did not stop when the model was created, but tested each model thoroughly through practical implementations.

3.2 Part 1 – Methodology and design

Research Question Part 1: Why are current ICT infrastructure development and IS education development projects not producing the required results? Can these existing projects be accelerated towards sustainability?

The study started as a critical review of existing ICT4D projects that influence graduate and/or enrolment numbers [the title of this thesis finds meaning here]. In this phase [time period] of the study, the researcher had doubts about the effect of infrastructure development projects on graduate numbers as opposed to the effects of education-based projects on graduate numbers. If an argument were to be presented in favour of education-based development later in the thesis, the design of this part of the study had to be done in such a way that it would give us the variables with which to compare the success of projects with each other, be they infrastructure or education based.

With this need for comparability between projects in mind, it was decided to focus on two variables for each project: (i) the amount of development that resulted from the project, and (ii) the maturity of the project. To measure project development output or project maturity level had not been done comprehensively in the IS literature at the time, so it was decided to build measures for each of these variables ourselves. The work of Sen (1999) was used to define measurable variables for project development outputs and used with existing software development project maturity models to help us build a development project maturity model. This research design worked well, enabling the measurement and comparison of the success or failure of ICT development projects in an easy, understandable way, asking two questions: (i) which project resulted in the highest development outputs and (ii) which project had the highest level of maturity?

Comparing development projects with each other was not the focus of this study. The focus was to find ways of improving existing IS graduate development projects, be they infrastructure or education based. For this reason the researcher titled this part of the study, “accelerating ICT development projects towards maturity”, and adjusted the wording of the research question to clarify this focus.

This study ended up being critical in nature [as the title suggests], finding a general lack of maturity in community-based ICT4D projects – with this maturity being dependent on several variables

measured during the course of the study. In order to be constructive towards answering the main research question of this thesis, the researcher published this critique, accompanied by suggestions for improving the levels of maturity and development output of ICT4D projects.

3.2.1 Data gathering

The research problem of this part of the study, namely how to accelerate the growth of freedom-generating ICT4D projects towards sustainability, lends itself well to both qualitative and quantitative research. From the literature and practical experience gained from the case study described in this chapter (the Computer Redistribution Project), variables for measuring project maturity were put forward – some requiring qualitative investigation and others quantitative support. Each suggested variable was tested by gathering qualitative data from the case study using semi-structured interviews, as well as frequent observations of case study participants. A small data sample of quantitative data was also gathered, which included the frequency/times certain variables were observed in action. A summary sheet of this data is available in Appendix 1.

It is important to note that this article added new variables to the measurement of project maturity as suggested by Leem *et al*. (2008). Leem *et al*.'s model in its original form was not complete for use in an ICT4D project context. The researcher amended Leem *et al*.'s model, adding new variables. Most important of the new variables that were added to the model were measurement for direct or indirect development outputs, called direct and diffused increases in freedom in the model.

To make the analysis more complete and sensible in the context of this chapter, maturity was measured *twice* early in the project [section 6.1, Tables 2 and 3] and *twice* when the project was one year old [section 6.2, Tables 4 and 5] – using Leem *et al*.'s original model *and* using the researcher's amended (more ICT4D oriented) version of Leem *et al*.'s model in each section. The comparison between measures gained from the original model and the amended model validated the newly added variables – mentioned in section 6.1 of Part 1 – and identified important key variables for measuring ICT4D project maturity. The researcher picks up on these comparisons and key variables when discussing the findings (see section 7 of Part 1).

The research methodology can thus be described as case study driven and qualitative, with the conversion of interview transcripts and observations into quantitative measures adding measurability and comparability. When reading Part 1 of this study, it is important to bear the original research design in mind – the researcher wanted to measure (i) project development outputs and (ii) project maturity in order to find variables that could influence project success.

3.2.2 Workflow

The researcher was actively involved for two years in the conceptualisation and implementation of the case study project for Part 1 – the Computer Redistribution Project (CRP).

The practical requirements of the CRP guided the flow of the research activities surrounding the project. In short, the maturity (which now included measures of development output) of every implementation of the CRP was measured twice – during the early phases of implementation, and between ten to twelve months after implementation. During the elapsed months between the two measurements, the researcher tried to influence project maturity variables in various ways in order to determine the validity of each variable, and the weight of its influence on project success.

The CRP, started in 2010, was finally discontinued in 2012, but not due to project failure. Our involvement with the four schools had highlighted the need for other ICT development initiatives at each of the schools (diffused development potential), which naturally followed on the groundwork done during the CRP.

The workflow for this part of the study included several visits to each of the four schools over a two-year period – at least two visits per school per year for data gathering purposes – and two computer literacy training weekends for all students who received computers as part of the CRP.

3.2.3 Data analysis

The semi-structured interviews conducted at each of the four participating CRP schools contained questions focussing on the identified project maturity variables. These variables were grouped into six categories that were each assigned a weight and thus constituted our maturity model for ICT development projects. The six categories are:

- Vision,
- Infrastructure,
- Organisation and rules,
- Support, trust, and the community's relationship with the project,
- Application and use, measurable increases in freedom (actual development outputs),
- Social recognition, celebration, and the role of media coverage.

To increase the comparability and the rigour of the qualitative research, interview answers were coded [looking for specific identifying elements within interview answers], informed by the

researcher's observations and quantitative measures, weighed on Likert scales, and then combined to provide the final measures for each of the six project maturity categories. These six weighted category scores were then combined, in turn, using Leem *et al.*'s (2008) model and weights to provide a single maturity score for each participating institution's implementation of the CRP. The result of this data-processing activity was a set of project maturity scores. These scores could be analysed easily according to the six measures that made up each score, and compared to practical observations of how each CRP implementation was turning out.

3.2.4 Appendices

A summary of the data gathered for this part of the study is available in Appendix 1.

3.3 Part 2 – Methodology and design

Research Question Part 2: What is the nature of the current IS graduate supply and demand? Does the human capital approach to labour supply give us any new insights into the existing IS graduate supply shortage? Why are so few students (and so few high-quality students) choosing IS or IT as a study field or career choice (hence choosing to become part of the IS graduate supply chain)?

In this section, the research design of Part 2 is discussed. As defined in the previous chapter, this part of the study focussed on analysing the existing IS skills shortage in South Africa with the aim of finding education-driven ways of increasing the supply (and elasticity of supply) of the needed IS skills.

The research design for this part of the study was originally based on an economic theory that can be summarised briefly as follows. If, in a neo-classic retail market, the demand for an item increased without any other variables undergoing significant change, the competitive market price of the item would increase – the market would shift along the supply curve to a higher price and a higher level of production. One of the classic problems with this theory was the concept of a product possibility frontier – the maximum quantity of the item that could be produced, regardless of its price. One cannot always assume that a higher level of production is possible.

It was found that the concept behind this economic theory – higher demand resulting in higher prices – could be applied with conceptual ease to IS graduates in South Africa. If the demand for IS graduates in South Africa were to grow, the competitive salaries of core IS occupations [at a graduate level] would increase – using the same mechanisms of market competition that would make the price of a retail item increase if demand for that item increased. As the price for IS graduates continues to increase, IS graduate supply would eventually reach its production possibility frontier – the maximum number of IS graduates that South Africa could produce under those conditions. It would not matter how much the demand for IS graduates were to increase beyond that point. The price for graduates would not rise much further, as increases in salary levels would not attract any more [or more adept] labour, and companies would be near their salary expenditure ceiling.

A classic supply-side answer to the production possibility frontier issue (in retail scenarios), as suggested in many first- and second-year economics textbooks, is to focus on increasing the price elasticity of the supply curve – resulting in increases in production (and production costs) having a smaller effect on item price levels. This can be done in several ways – making actual production per unit cheaper, manufacturing the product in several locations (thereby cutting distribution costs), and so on.

From preliminary reading, the researcher suspected that the South African IS labour market had reached its production possibility frontier. This was evident from the literature and from media publications on the IS skills shortage during 2010 and 2011. It was the question – how to stimulate a labour market that had reached its production capacity by increasing the price elasticity of this labour – that directed the research design for this part of the study. Human capital theory was used as entry point into IS literature, after which the focus of this section was to find education-based variables that could influence the price elasticity of IS labour supply.

This study, Part 2, can be described as positivist in nature, as it was built on the statistical analysis of a large-scale survey that interrogates possible IS labour supply elasticity variables.

3.3.1 Data gathering

In order to analyse (i) the size and nature of the IS skills shortage, (ii) what the current production possibility frontier of IS labour was, and (iii) what magnitude of change in the price elasticity of this supply had to be facilitated in order to address the IS skills shortage, the researcher needed reliable, detailed information regarding both the supply and demand for IS skills in South Africa.

We step aside for a moment to define the occupations included in this study's definition of IS labour supply and demand. In Part 2, the focus was primarily on core IS skills at a graduate level – business analysis, systems analysis, data modelling and software development. Mobile application development [as an occupation] was included in the data measures for Part 2, in order to make the data relevant to Part 3, where the focus is primarily on mobile application development short courses as a proposed solution to one of the skills gaps in the IS graduate supply chain. For an expansion of these definitions, see section 1.7 regarding Core ICT labour and labour within the creative industries.

Let us return now to the need for IS labour supply and demand data. To construct the demand side of the skills shortage, several recent publications and surveys of ICT industry vacancy data were combined. The supply side of the labour market was constructed using available graduation data from leading universities.

Acquiring an understanding of the nature of the group of students and school learners that together constitute the IS graduate supply chain – in order to find ways of increasing the elasticity of this supply – was a far more intensive task. This intensive part of the data gathering activities involved creating and administrating a large-scale survey that was made available to more than 7 000 first-year students at a leading local university. First-year students were chosen as target population for the survey, as they were the group of students from which potential IS graduates would mature. The survey was made available to these students early in their first year, when reasons for their study choices would still be reasonably easy to recall, and would be unaltered by their experiences as tertiary-level students. The response was good – 4 475 students from a wide variety of graduate courses completed the survey. The data was processed into data sheets. A summary of this data is available in Appendix 2.

3.3.2 Workflow

It became clear during the early stages of this part of the research study that the largest part of the workload would involve the administration and statistical analysis of the large-scale student survey aimed at understanding the nature of the supply side of the IS labour market and the variables that motivate students to study IS.

The survey was created and made available online to all first-year students at a local university, and remained available for a month. The survey data was processed, statistically analysed, and used to

create a model that, by using non-linear regression analysis, provided us with weights indicating the importance [level of significance] of all the supply-side variables used to construct the model.

3.3.3 Data analysis

The survey was set up to test the validity of ten supply-side variables – variables gained from the literature and variables that were found to be significant in Part 1. This ten-variable model was matched to the data using an open source regression analysis software package[9], with the dependent variable being the student's choice for or against IS as study direction. The results showed five of the ten independent variables to be statistically significant – giving us five pointers towards how the group of students that would eventually [potentially] become part of the South African IS labour supply could be grown. These results, and other statistical measures gained from the large-scale survey, are discussed as findings in Part 2.

3.3.4 Appendices

A summary of the survey data, a description of the ten-variable supply-side model, and results of the statistical regression analysis of the model are available in Appendix 2.

3.4 Part 3 – Methodology and design

Research Question Part 3: Can short IS transition and reskilling courses be implemented as sustainable projects that will assist a typical IS department in increasing the quality and quantity of first-year enrolments and the quantity and employability of final-year graduates? Were these projects successful in increasing graduate supply [supply elasticity]?

Part 2 resulted in a set of education-based variables for increasing the supply, and elasticity of supply, of IS graduates in South Africa. These variables directed the research design of Part 3, as they suggested a particular type of education approach as remedy for the IS skills deficiency – short, flexible transition and reskilling courses that fill severe skills gaps in the short term, while existing education structures [institutions] are being accelerated towards higher levels of graduate development in the long term.

[9] Package called "R", available online: http://www.r-project.org/

In Part 3 of this study, the workload picked up significantly, as very few of the IS courses that were available in 2011 matched the character [short transition/reskilling nature] prescribed by Part 2 as the type of course that could stimulate a sufficient increase in IS graduate supply elasticity. These courses first had to be developed.

Two mobile application development short courses were developed as part of the research design for Part 3 – course outlines, syllabi, slides and lecture notes – and implemented at two local universities in South Africa. The one course was structured as a transition course guiding secondary school learners towards tertiary IS study, and the other course took form as part of a postgraduate diploma in software development, reskilling non-IS students towards employment as software developers.

The two courses presented as case studies in Part 3 allowed the researcher the opportunity to conduct in-depth action research regarding the ability of each course to improve graduate [or enrolment] numbers. It also allowed for the measurement of student quality variables, such as employability, aptitude, entrepreneurial potential, and attitude towards industry-related group work.

3.4.1 Data gathering

The focus of this study required the capture of measures that would indicate clearly whether or not a secondary school learner or a graduate student would form part of the IS labour supply or not. These measures were taken prior to each course and again after the duration of the course. See Appendix 3 for an example of a course outline, syllabus structure, registration questionnaire, and a questionnaire submitted after course completion.

3.4.2 Workflow

What started out as a suggestion at the end of Part 2 of this study – that short transition and reskilling courses could be used to increase the elasticity of IS labour supply – turned into arguably the largest part of the practical development work this thesis was based on.

The researcher developed two short courses – one transition course and one reskilling course – and promoted these courses at two local universities. The courses were accepted [welcomed] and the researcher lectured both the courses during the second semester of 2012. Data was collected in July and November, and compared for indications of graduate development.

With confirmed early successes for both courses, and lessons learnt from the application of the framework presented in Part 4, a similar workflow for these two projects was set to continue in 2013 at the time this text was written. See the findings of Part 4 for a discussion relating to how the courses had been improved from 2012 to 2013.

3.4.3 Data analysis

The researcher wanted to confirm whether short courses of the described nature could present an education-based solution to the growing IS skills shortage. The data analysis for Part 3 was geared towards this end, investigating variables for increases in employability, industry skills matching, enrolments, and entrepreneurial potential. As a reaction to the findings in Part 2, the researcher was also interested in variables that motivated learners to study IS at the tertiary level, and included these in the questionnaire at a basic level, asking questions such as “What is your dream job?”, “What do you plan to study one day?”, and “Who/what motivated your study choice most?”, with lists of possible answers supplied where necessary.

Data analysis tasks included capturing the data from pre-course and post-course questionnaires and comparing them manually – one student’s data at a time – for signs of project success.

3.4.4 Appendices

Summaries of the data used for this part of the study, with supporting documents, are available in Appendix 3.

3.5 Part 4 – Methodology and design

Research Question Part 4: Can the research findings of this study be combined into a framework that will assist IS departments in increasing the quality and quantity of their enrolments and graduates, thus answering the primary research question of this study?

From the outset of this study, the researcher wanted to present more than the title-implied critique of projects that try to increase the quality and quantity of graduate students. This thesis was designed to end in Part 4 with an answer to our critique – an inclusive framework for graduate development.

Part 4 serves as the contribution of this thesis. The IS Graduate Development Framework (ISGDF) is presented in this part of the text as the result of several findings from Parts 1, 2 and 3. Part 4 is divided into two sections: (i) the concept article that presents the ISGDF and demonstrates its use, and (ii) a supplementary section that presents the mobile application that was developed to support the initial findings of the ISGDF.

As in Part 3, the case study-based design of Part 4 lends itself to action research. The discussion of findings at the end of Part 4 can be classified as interpretive in approach.

3.5.1 Data gathering

As this part of the study takes the form of an article that presents a conceptual framework, the only data gathering that had to be done involved data from testing the validity of the framework. The framework consists of twenty measures that are subdivided into 43 questions. Test data for the framework constituted three sets of answers for the 43 questions (all in Likert scale format, requiring an answer between 0 and 5) gathered during a case study. This data gathering exercise, and the results, are discussed at length and transparently in the case study section of Part 4. See Appendix 4 for an example of the 43-question framework and a summary of the gathered data.

3.5.2 Workflow

The ISGDF is based on four streams of IS literature related to IS graduate development. With Part 1, 2 and 3 of the study as a foundation, the framework could be constructed using variables from all four fields of IS research.

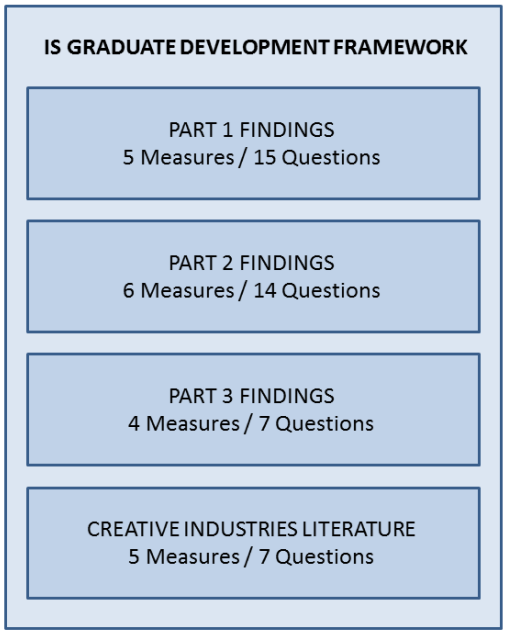


Figure 6: Designing the IS Graduate Development Framework

The framework, as outlines in Figure 6, was constructed and tested in a case study. This resulted in valuable insights regarding successful graduate development projects, and in the development of a mobile application that supported the suggestion made by the framework. The researcher developed the mobile application for the Android platform first, using Java and XML as development languages. Attempts were then made to port the application to the BlackBerry 10 platform, with reasonable success.

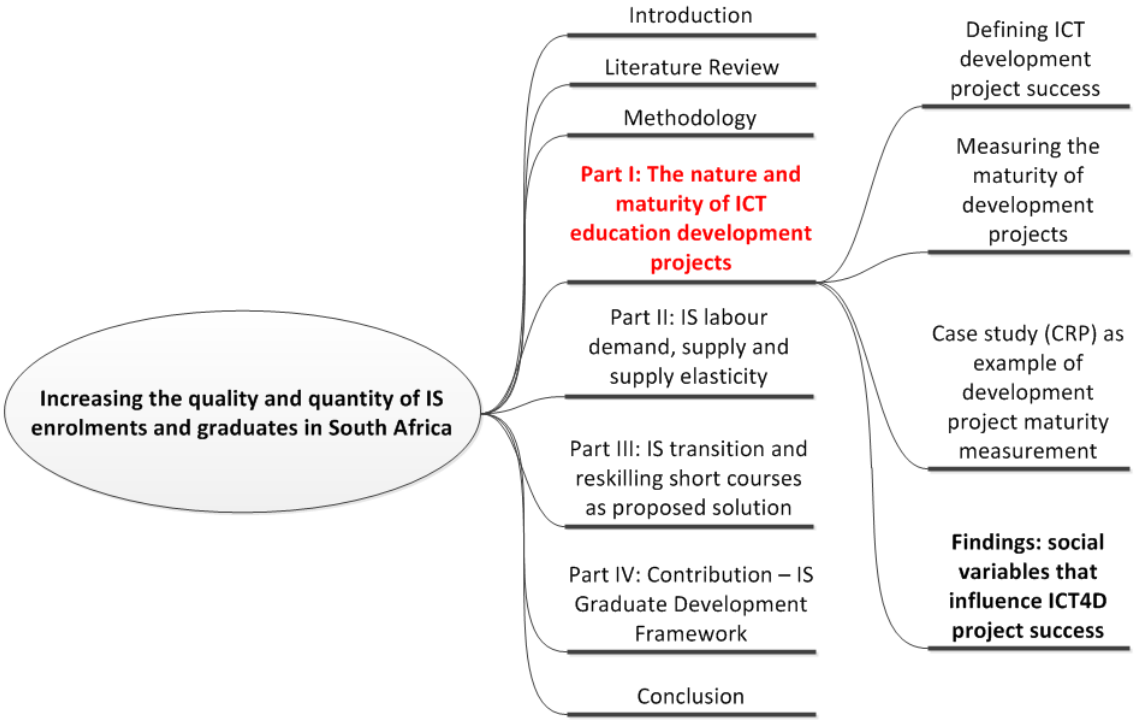
3.5.3 Appendices

A summary of the data gathered for this part of the study is available in Appendix 4.

3.6 Conclusion

In this chapter the research design and methodological approaches followed throughout this thesis were discussed. The first research results are presented in Part 1 of the next chapter.

CHAPTER 4: PART 1 – ACCELERATING ICT DEVELOPMENT PROJECTS TOWARDS MATURITY



4.1 Introductory notes

"Freedoms are not only the primary ends of development, they are also among its principal means." – Amartya Sen (Sen, 1999)

The purpose of this part of the thesis is to build an understanding of what the key characteristics of successful ICT4D projects are, and how these characteristics can be stimulated in development projects to increase their chances of success. The findings from this chapter were used to inform the IS Graduate Development Framework presented in Part 4 of this study.

When the researcher set out to measure variables that influence the success of technology-oriented development projects, he could not find any suitable models or frameworks in the literature to facilitate such a measurement process. Models existed for the measurement of software implementation success and its resultant developmental impact [in such scenarios, increases in productivity are usually seen as the measurable variable], but these models lacked the social sensitivity required. It was decided to take one of these models, a software implementation maturity model called the Five Stages Maturity Model (Leem *et al*., 2008), and to adjust it so that we could use it to measure the success of technology-oriented development projects.

This chapter thus starts out on an offbeat rhythm – the social development that results from ICT4D projects cannot be measured if there is no satisfactory measuring tool. After adjusting an existing maturity model to our needs, the chapter accelerates towards answering its research question – how can ICT4D projects be accelerated towards sustainability.

Part 2 and Part 3 of this thesis frequently refer back to the findings in this chapter and, with sensitivity, generalise some of these findings, applying them to education-focussed IS development projects. This is a significant jump – from infrastructure development in the ICT4D domain to skills development in the IS education domain. Care is taken in this part of the study, Part 1, to build an epistemological bridge between these fields of study through the use of Sen's definition of development (Sen, 1999). Sen defines development as increases in freedom (explained fully in this chapter), and with this definition he brings the goals and the measurement of infrastructure development projects and education-based development projects closer together – both should increase the freedom of participants, and these increases can be measured.

The findings in this section of the thesis are used later in the construction of the contributory framework in Part 4. Even though the establishment of these findings was the primary goal of this chapter, it is noted that, as a secondary outcome, the newly adjusted, socially sensitive maturity model resulting from this chapter can be useful in future studies, and deserves further development through regression analysis.

4.2 Article

Breytenbach, J., De Villiers, C., & Jordaan, M. (2012). Communities in control of their own integrated technology development processes. *Information Technology for Development, 18*(4), 133-150. doi:10.1080/02681102.2012.714348.

Communities in Control of Their Own Integrated Technology Development Processes

Abstract

This study investigates technology driven, development focussed initiatives [ICT4D projects] at a community level in South Africa. This study forms part of the existing debate on ICT4D project success, and suggests answers towards accelerating ICT4D projects' growth towards maturity and sustainability. Concerns that receive attention include the level of ownership and control taken by members of benefiting local communities in ICT4D projects, the level of social embeddedness of ICT4D projects, and a revision of the concept of sustainability within the ICT4D context. A detailed case study that compares two ICT4D project implementations influencing four local communities, focusing on educational institutions within the communities in South Africa, provides the foundation for this article.

Adjustments are made to the Five Stages Maturity Model for ICT projects (Leem, Kim, Yu, & Paek, 2008) and then used to guide our critical discussion regarding each community's relationship with the ICT4D projects currently running within each society, and how these relationships can be matured and sustained. Findings include a discussion of the importance of direct and diffused increases in freedom resulting from an ICT4D project and the often discounted role of recognition, celebration of achievements within the local community, and media involvement in the maturity, and hence sustainability, of ICT4D projects.

Keywords: technology development; social development; ICT for development [ICT4D]; sustainability; maturity models; project maturity

1) Introduction

This article presents the first results from research-in-progress to develop a framework for the design and evaluation of ICT4D projects - based in part on sustainability and maturity variables – that will successfully increase the quality and quantity of ICT enrolments and graduates. The authors describe their first results towards this framework using findings from a case study: the Computer Redistribution Project.

This study leans heavily on two definitions and their underlying assumptions [philosophies]: (i) the definition of development as active increases in freedom(s) and ICT4D projects as projects that increase freedom(s) using some form of information technology, and (ii) the definition of ICT4D project success as a state of project maturity and sustainability (This will be explained in detail in paragraphs 1.1 and 1.2 of this part of the text).

The first of these philosophies – development as active increases in freedom – is founded upon the works of Sen (1999). The second – project success as a state of maturity – is founded upon the IT maturity model put forward by Leem (Leem *et al*., 2008). Leem's Five Stages Model (Leem *et al*., 2008) for IT project maturity fills in some of the major shortcomings [regarding maturity] of other literature mentioned in the literature review section of this article. Leem *et al*. (2008) provides valuable insights into the kind of relationship between project and community (members) that make projects succeed and accelerate the growth of such relationships. Leem's definition of maturity and sustainability as a developmental process that happens over time (Leem *et al*., 2008) is epistemologically useful in this article, as it echoes some concepts discussed in Sen's work on development oriented projects (Sen, 1999), such as the concepts of diffusion and integration. See Table 1 in section 3.3 for a summary of Leem's model and how it relates to Sen. We start to see an ICT4D project as something that, in itself, develops over time towards sustainability, while developing other entities. Each development project, according to the Leem model, grows through stages of maturity (towards sustainability) and is not necessarily cyclic in nature, contrasting it with other views of sustainability in the literature (as an example, see Pade-Khene, Mallinson, & Sewry, 2011).

This article uses Leem's maturity model as a point of departure towards our contribution to the body of knowledge concerning ICT4D project maturity. This model has, however, only been tested in an enterprise IT project maturity environment, and we therefore adjust this model later in this article [chapter] to make it a better suited measuring tool for ICT4D project maturity. We adjust the model

by informing (expanding) it with development project maturity variables extracted from the works of Sen (1999) and test our adjustments to see whether or not they describe our case study findings more accurately or not.

These alterations made to Leem's model, even though we suggest them with good reason and statistical support, are *not* the primary focus of this article – our alterations will have to undergo more rigorous testing and regression analysis before it can be accepted as part of a proper ICT4D maturity model. The action of altering Leem's model is undertaken as a means of creating a project maturity measurement tool that is capable of answering the research question of this study: how can the process of maturing ICT4D projects towards sustainability be accelerated? Leem's model, as it stands in literature (Leem *et al.*, 2008) guides us in the right direction, and lends itself well to use within the ICT4D field, but cannot answer our ICT4D focussed research question fully without undergoing minor adjustments.

When we inform the Leem model with the works of Sen (1999), we *accelerate* in the right direction. Describing *how* to reach ICT4D maturity stage *faster* is the purpose of this article. Our findings are practical guidelines towards reaching ICT4D project maturity based on case study measurements using both Leem's model and our adjusted (more ICT4D oriented) version of the Leem's model, rather than mere alterations to an enterprise IT maturity model.

Before delving deeper into the research question of this paper, how ICT development projects can be accelerated towards success, it makes sense to clarify what we see as development, a development project, project maturity, and project sustainability. The following subsections of this introduction describe the concepts of freedom, freedom as development, and project sustainability, and inform these important definitions from pertinent literature. These sections are not compulsory reading, but will assist the reader in understanding why the authors approached the research question the way they did.

After discussing these underlying definitions in sections 1.1 and 1.2, the research question of this article [chapter] is delineated in section 2, followed by a literature review in section 3, and an explanation of the research methodology used for this article in section 4. In section 5 we give a detailed discussion of the case study informing this article, followed by extracts from the case study data in section 6 and findings and suggestions in section 7.

1.1) A definition of development

In accordance with Sen's definition of development as the "increase of an entity's freedom" (Sen, 1999), members of a society start developing themselves and their community when they begin to actively rearrange the social resources and structures under their control in ways which result in greater freedom (a larger spectrum of action choices and opportunities available) to themselves and/or other members of the community. Freedom, in turn, is defined as the number of options available to an entity to pursue goals it deems important (Sen, 1999). These freedoms include economic freedom, freedom to participate in commerce, democracy within political structures, greater access to nutrition, to health care, to education.

In this article the authors use the definition of development as freedom to argue that members of a community gain momentum towards the maturity of their ICT4D projects when they not only identify an ICT4D project's potential for development towards greater freedom (level 1 and 2 maturity, as discussed in the section on project maturity – section 3.3), but when this realization of development potential is actively pursued and taken ownership of by members of the community and integrated into its social structures through repetitive actions/choices aimed towards the identified developmental outcomes (reaching level 3, 4, or 5 maturity).

In education driven development projects, the focus of Part 2 and Part 3 of this study, this concept of an increase in freedom would translate into (i) students making use of the development potential of a course by making it their own and implementing it in their sphere of influence in a way that increases their financial or social freedom, and (ii) educators [and educating institutions] taking ownership of such development courses by integrating them into institutional structures in such a way as not to diminish the project's development potential.

The field of study documenting the developmental character of technology [projects] is often referred to as Information and Communication Technology for Development (ICT4D). Within the African context examples of technology used to increase the freedoms (ICT4D projects) within communities abound – greater access to information, cheaper access to education, enhanced career opportunities, to name but a few. See, as South African examples, Parkinson's work on telecentres (Parkinson, 2005) and Coetzee's work on code sprints (Coetzee, 2010). Examples of currently running ICT4D projects that informed this study include the work of the Meraka Institute (Coetzee, 2010), the Siyavula organisation and Free High School Science Textbook (FHSST) project[10], and the projects

[10] http://www.siyavula.org.za

studied by Pade-Khene *et al*. (2011). A new term, Community Informatics (CI), has also found its way into literature, and provides another avenue to examples of the developmental character of Informatics[11].

We note at this point that technology projects that increase access to education, and educational projects regarding the use of technology for societal development form part of the ICT4D body of knowledge. We use the flexibility of the definition of ICT4D, particularly its inclusion of education based development projects, when generalising our findings from this first part of the thesis to apply to education driven IS projects in Part 2 and Part 3 of this text.

1.1.1) Direct increase in freedom

A further classification of the development – an increase in freedom - brought about by typical ICT4D projects is needed before looking at Leem's maturity model for technology projects (Leem *et al*., 2008).

Sen (1999) introduces us to **five types of freedom** that can be increased, for specific social entities, through thoughtful developmental actions such as ICT4D projects: economic freedom [greater income, fair competition], social freedom [better health care and education], political freedom [access to unbiased information and to freedom of expression], trust relationships [between authorities and subjects], and access to security resources [legal justice, police force, prisons].

When discussing development as a product of successful ICT4D projects, it must be possible to tie the development back to an increase in one of these five abovementioned types of freedom. If freedom has not measurably increased then, by our definition, no development has taken place. If freedom has not increased due to an ICT4D project, the project is, per definition, not successful, not mature, and not sustainable.

1.1.2) Diffused increase in freedom

ICT4D projects usually aim, as part of predefined project goals, to increase a specific type of freedom for a specific group of community members. Parkinson (2005) aims towards increasing social freedom through greater access to information. Coetzee (2010) aims towards increasing economic freedom by supporting start-ups in the software development industry. The Dwesa project, as described by Pade-Khene *et al*. (2011), aims towards increasing economic freedom through the use of e-commerce-driven tourism. The project discussed in our case study aims towards increasing

[11] http://www.ci-journal.net; *Journal of Community Informatics*, available online since 2005.

social freedom through greater access to information and an improved level of academic syllabus delivery.

Using Sen (1999) as foundation, we broaden the spectrum of potential developmental outcomes of ICT4D projects by observing that ICT4D initiatives increase the freedom of the benefiting community members on a broader scale than just within the category of freedom it is directly addressing. Sen (1999) refers to this concept as a *diffusion* of development potential. For example, an ICT4D project with a social focus (education, communication) can unwittingly increase the economic freedom and/or the political freedom of members within that community while striving to increase only the social freedom of a selected few within that community. From our case study we suggest that such *diffusion of development potential* will only happen if members within the benefiting community take ownership [control] of their ICT4D projects and the rearrangement of social structures required by these projects (level 4 maturity leading to level 5 maturity).

Moreover, *diffusion of development potential* is mentioned as a critical step towards project maturity (and hence project sustainability) during this article's literature review of maturity models (Leem *et al*., 2008). This link between Leem's maturity model and Sen's definition of development is the primary reason for the use of Leem's model as measurement tool later in this article.

1.2) A definition of success

In this article we categorize an ICT4D project as successful when it has matured over time to a place of sustainability and local ownership. Sustainability within this context does not refer to the economic concept of sustainable advantage of ICT projects, but a scenario where a project has matured to a point where it has gained enough economic footing and social momentum to survive without large investments from non-local benefactors. A project is sustainable if it can continue to grow using only local resources and management. This definition is supported by Pade-Khene *et al*. (2011).

How do we measure sustainability? According to Avgerou (2009), there are two measures with which the social character of ICT4D projects and the relationship between a community member(s) and an ICT4D project can be described. Both measures assist the researcher in gauging project sustainability.

- A project can be described by its level of *social embeddedness*, with the two extremes on this spectrum being "a foreign project transferred into a community with no epistemological

roots within the community" and "a truly locally developed, locally rooted community initiative".

- A development project can also be described according to how *progressive or disruptive the social structure rearrangements linked to this project is perceived* (experienced) by members of the involved community.

We observe, justified by data gathered from our case study, that communities take ownership of projects faster, and therefore accelerates the move towards sustainably increasing the freedom of community members, when these projects were originally initiated within the benefiting community (by the community, for the community) - it has a high level of social embeddedness. Development projects that are perceived as disruptive will be [more readily] accepted by communities only if these projects have a high level of social embeddedness.

Even with a high level of social embeddedness, an ICT4D project's local ownership and integration into existing social structures (level 3-5 maturity) cannot be guaranteed, as shown in our case study examples. Something more is needed to push a project into the sphere of sustainability and local ownership, allowing external resource investment to withdraw over time. From our case study we suggest social recognition and celebration of achievements as a frequently overlooked yet important variable influencing ICT4D project success.

The role of social recognition, celebration, and media influence on ICT4D project success scarcely receive any mention within literature. In the remainder of this article the authors suggest that, together with diffused increases in freedom, this is a critical variable of ICT4D project sustainability [success]. We return to this argument in our discussion of the case study project.

The following sections of this article presents the research problem of this article, a literature review, a brief description of the research methodology and case study design, data measures and findings.

2) Research Problem

With development, freedom (direct and indirect increases of freedom), project success, and project sustainability defined, we delineate the research problem of this article as follows. How can the process of maturing ICT4D projects towards sustainability be accelerated?

3) Literature review

With the work of Sen (1999) and Avgerou (2009) that we discussed in the introduction to this article as foundation, a brief overview of pertinent answers provided to our research problem in the literature follows. It is worthwhile to note at this point that none the works of Sen (1999, 2009), Avgerou (2000, 2009) or Leem *et al*. (2008) stand beyond reproach. These studies, particularly the works of Sen on development and the sustainability of development, are currently accepted and generally regarded as progressive in the greater global development discourse.

3.1) Socially embedded projects

Avgerou (2009) provides us with two useful measures for ICT4D project sustainability: (1) social embeddedness, and (2) the perceived level of disruption within existing social structures caused by the ICT4D project in question. We suggest that these measures can be visualised as the two axes of a Cartesian plane; see Figure 7: The social character of ICT4D projects.

This study moves beyond Avgerou's classification of ICT4D projects (Avgerou, 2009), to how ICT4D projects can be *accelerated* towards sustainability. We assume that the highest level of sustainability is found in the first quadrant of 5 (non-disruptive, socially embedded projects), and from our findings make suggestions regarding how projects can be positioned aiming towards this space.

ICT4D projects mature faster when they are community driven. From mistakes made in the past (Escobar, 1992) it is now clearly documented in literature that self-developing communities will follow a *uniquely different and more successful developmental process* – and use technology differently within this process – while taking charge of their own development as opposed to when the communities are *being developed* (or guided through developmental "best practices") by so-called "developed" communities (Avgerou, 2000; Krauss & Turpin, 2010).

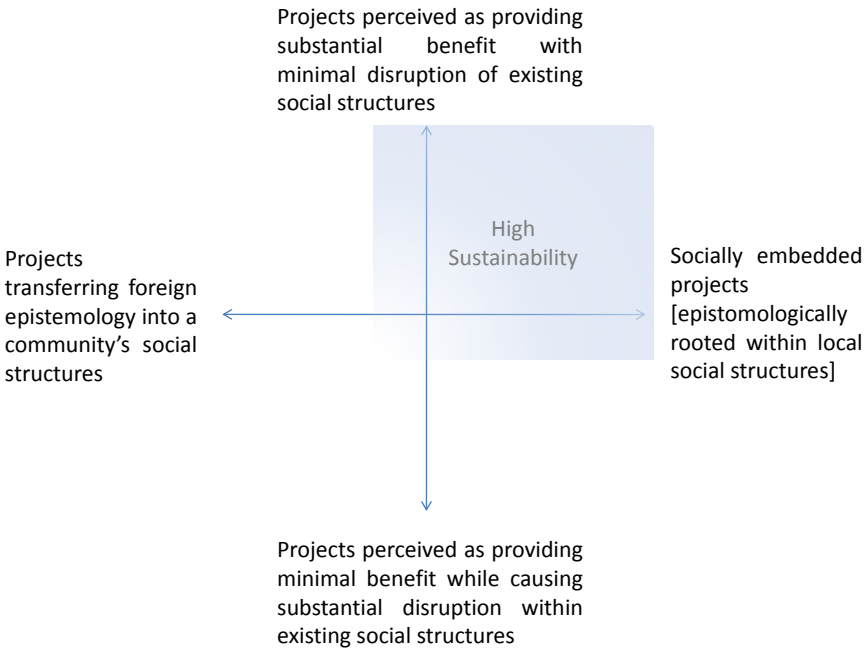


Figure 7: The social character of ICT4D projects

3.2) By the community, for the community

Grassroots initiatives, loosely defined by Escobar (1992) as local development initiatives, managed by members of the local community for the benefit of the local community, have been observed to mature well, as opposed to development initiatives managed directly by members of foreign communities, or initiatives enforcing foreign epistemological assumptions (Escobar, 1992). Coetzee (2010) reinforces the concept of ICT4D "by the community for the community" with his continuing research of ICT4D within the South African context.

From both these sources the success of the grassroots approach is accredited to two characterising factors. First, the developing community does not feel as if it is being forced into participating in foreign practices on any level, ontologically or epistemologically, and therefore allows the initiative to form part of its social structure. Even though the technology used might have been designed in a foreign, already developed community, for use in a developed community (ontologically a poor fit within the developing country's developmental process), its implementation within a grassroots context remains free from the erroneous epistemological assumptions of the old western development discourse, because the project has its roots [is socially embedded] within existing social patterns within the community. The concept of grassroots development reinforces the concept of social embeddedness, as discussed in the previous section.

Second, after being allowed into a community's social structure, grassroots movements gain momentum *faster* as social structures are rearranged (Coetzee, 2010; Escobar, 1992). As a fundamental building block of his social theory, Giddens proposed as part of his Structuration theory that a society is the result of its actions and continuously redefines itself by choosing to act and react in certain ways (Giddens, 1984). Communities gain momentum in a certain activity [project] by continuously choosing to perform again and again that activity in a certain way. It is not enough for a community to work towards having greater economic freedom, or social freedom, or political freedom, or any other goal of ICT4D projects, by performing a once-off rearrangement of social structures. The newly identified development possibilities must be acted upon, and acted upon continuously – the reactive choices within the community must change course and gain momentum in a new direction – for the community to change its identity, and develop [growth of freedom] in a new direction. Njenga and Fourie (2010) agrees on the importance of the process of rearranging social structure, stating that the value of and ICT initiative does not always manifest as sustainable advantage (or sustainable development) but rather in the long-term social structure changes resulting from the investment in ICT. We interpret these extracts from literature as follows: socially embedded ICT4D projects mature faster, and accelerate faster towards sustainability than poorly embedded projects.

In another recent South African study, Pade-Khene *et al*. (2011) strengthens the discourse in favour of "by the community, for the community" projects by listing a "community-driven approach" as one of key success factor of ICT4D project success.

Judging from the literature discussed thus far, ICT4D projects have a clear path towards maturity set out before them, at least theoretically: (1) make sure the project is epistemologically well embedded within, and not overly disruptive of, the benefitting social structure (Avgerou, 2009; Pade-Khene *et al*., 2011); (2) aim towards increasing the freedom(s) of community members, thus ensuring measurable developmental outcomes (Sen, 1999); (3) aim towards gaining momentum (and thus becoming sustainable faster) by making sure community members make a habit of positively supporting the project (adjusted from Giddens, 1984).

These suggestions are valid - we will comment on them again when discussing the findings of our case study - but conceptually they disqualify the majority of active South African ICT4D projects from ever becoming sustainable. First, most South African ICT4D projects are weakly embedded within the benefitting social structures – an ICT4D 0.0 or 1.0 approach, as categorized by Heeks (2008). An interpretive discussion of such scenarios is provided by Krauss and Turpin (2010). Second, an

abundance of charity [non-profit] development projects has created a culture where hand-outs and charity benefits are readily available (Sen, 1999, 2009; Tambulasi & Kayuni, 2005) and easier to obtain than the proposed benefits of hard work within one's local community or commitment to long-term, freedom-enhancing projects. Third, as a result of weak embeddedness and high levels of disruption (Avgerou, 2009), a culture of charity handouts, and the abundance of seemingly plausible quick fixes, momentum (as previously motivated from Escobar (1992), Coetzee (2010) and Giddens (1984)) becomes hard to build. Changes within social structures become hard to motivate from within the community. From our case study we argue that even if the abovementioned three elements are solidly in place within an ICT4D project - this being the case in few South African ICT4D projects (Tarwireyi, Terzoli, & Muyingi, 2008), sustained success is not guaranteed. Projects are often not even moving in the direction of sustainability.

Something is *lacking* – the glue [the drive] that will hold the freedom-generating ICT4D vehicle together long enough, and push it in the right direction fast enough, for it to become sustainable (reach at least level 3 maturity, as discussed in the next section). The need for greater freedom is growing, as is the understanding that ICT4D holds one possible key to sustainable development (Coetzee, 2010; Pade-Khene *et al*., 2011), but still ICT4D projects are failing during early stages of implementation (level 1-2 maturity), especially when external support and resources (volunteers and funding) decrease. ICT4D success is not solely dependent on getting development to take place [for which the theory is well established], but on a mature relationship between project and community (Krauss, 2009). Moreover, it is not enough to state that this relation should be socially embedded, locally driven, maturing, or gaining momentum – we need to describe *how* to create projects with this sustainable character; a character that can withstand the withdrawal of funding or external support.

3.3) Project Maturity

Leem's Five Stages Model (Leem *et al*., 2008) for IT project maturity has already been discussed in the introduction to this article. Table 1 provides an overview of this model.

Table 2: Summary of Five Stages Maturity Model (Leem *et al*., 2008), with applications in the literature

STAGES	Description	Link with Sen (1999)	Link with Avgerou (2009)
1) Initiation	Project is conceptualised; investments are made;	Unsure if project will result in any increase in	Initial character of project becomes apparent: level of

	implementation within isolated environments is completed.	freedom(s). Very low initial developmental impact, even with intensive resource investment.	social embeddedness, level of social disruption. Level of allowance and momentum is very low.
2) Recognition	Acknowledgement of project as a source of potential development, benefit(s). Still requires a high level of external resource investment, external motivation.	Community members experience small but distinct increases in freedom directly related to the project. Still a very low level of developmental impact.	The community allows the project to become part of its social structure and tolerates a higher level of disruption.
3) Diffusion	The project's influence starts to grow outside the initial implementation environment, with already benefitting members experiencing greater benefits or sustainability	The project increases freedom of community members beyond original intent – possible diffusion of development potential between classifications of freedom. Medium developmental impact.	A change in the community's perception of the project: greater acceptance of social changes due to visible direct and indirect benefits. Community starts to recursively support project with their actions (Giddens, 1984).
4) Control (Ownership)	Local community takes control of the project (see again notes on grassroots project); outside resource investment becomes less significant to project sustainability.	Community members identify the potential benefits of the project as important freedom within the community. Freedom(s) are continually being increased – high developmental impact.	Social structures have been rearranged to allow for the continual functioning of the project within the community. Project is no longer perceived as disruptive or epistemologically foreign.

5) Integration	Project is locally sustainable, locally managed according to local development strategy, supported by community members, part of how the community functions. Project can handle/manage changes to internal and external environments.	The increase in freedom (direct and diffused) that the project brings has been fully acknowledged, and the project is a constant growth factor within community.	The project is sustainable and perceived as such. The relationship between project and community is strong, well tolerated, and has momentum.

From the model, three things become clear. A development project can only be categorized as mature, which implies sustainability, when three things has happened in the relationship between the project and the community: (1) recognition and affirmation of the project's potential developmental benefit(s) by the community; (2) visible signs of *diffusion*, which we reinterpret as diffused increases in freedom, and (3) ownership of the needed social resources/structures by local community members. See Table 1 for a reference of how these factors tie into the literature covered earlier in this section. During case study research activities, which in many cases resembled an action research project going through the same developmental stages as mentioned above, the authors continually asked themselves how these three things might be motivated, accelerated, or created where absent within a community-project relationship. These three factors, in addition to other factors already mentioned from extant literature, are fundamental to the maturity, sustainability and success of ICT4D projects.

With these factors in mind (mentioned again in section 7), we can almost conclude our revision of answers to our research question from the literature. There is however one more voice, a surprisingly silent one, that proposes an answer to our research question from literature.

3.4) Social recognition, celebration, and the role of the media

In their article studying the media coverage of a well-known ICT4D project in South Africa, Chigona and Mooketsi (2011) confirms the importance of public perceptions in ICT4D and the role of the media in shaping these relationships between community and project. Using Habermas's theory of communicative action as foundation for their critique (Habermas, 1984), the article interrogates the various validity claims behind the ICT4D media discourse in question. Their findings include distorted

validity claims, ungrounded assumptions, and clear evidence of undeclared political agendas behind ICT4D in South Africa (Chigona & Mooketsi, 2011). They find that, untruthful or not, the media's portrayal of the success of this ICT4D project has been accepted, and enthusiastically supported, by community members involved.

We argue that the media can be to the benefit of ICT4D – specifically positive, public recognition of involvement in ICT4D and achievements by active community members related to ICT4D – to accelerate the move towards project maturity and the incorporation of ICT4D into the community's social structure. This kind of positive social recognition and celebration of achievement can motivate greater local involvement, local ownership, lower perceptions of disruption and enable a diffusion of increases in freedom created by ICT4D projects. To support this argument, a case study is reflected upon in sections to follow. We note that social recognition and celebration of achievements are not mentioned as factors influencing project success/sustainability by any previously mentioned literature sources.

With our survey of extant literature complete, we put forward our research methodology and a case study describing two similar ICT4D projects in South Africa. We classify the case study project's initial character according to Avgerou's framework (Avgerou, 2009), as well as the framework in Table 1, adjusted from Leem *et al*. (2008). Throughout the discussion of the case study our definition of development is aligned with that of Sen (1999), and our definition of success with that of Avgerou (2009) – as described in section 1.1 and 1.2.

4) Research methodology

The research problem of this article, how to accelerate the growth of freedom-generating ICT4D projects towards sustainability, lends itself well to both qualitative and quantitative research. From literature and practical experience gained from the mentioned case study, answers to our research problem were put forward – some requiring qualitative investigation and others quantitative support. Each suggestion was tested by gathering qualitative data from the case study using semi-structured interviews as well as frequent observation of case study participants. A small data sample of quantitative data was also gathered – the number of times certain observations were made, etc.

The semi-structured interviews contained questions focussing on each identified factor of project maturity. To increase the comparability and the rigour of the qualitative research, interview answers were coded, informed by the authors' observations and quantitative measures, weighed on Likert scales, and then combined to provide measures for each factor of project maturity. These factors

were then combined using Leem's model and weights (Leem *et al*., 2008) to provide a maturity score for each participating institution's relationship with the project.

It is important to note that this article adds new variables to the calculation of project maturity suggested by Leem *et al*. (2008). Therefore Leem's model in its original form is not complete for use in an ICT4D project context. The authors amend Leem's model, adding new variables. To make the analysis more complete and sensible in the context of this article, maturity was measured *twice* early in the project [section 6.1, Table 2 and 3] and *twice* when the project was one year old [section 6.2, Table 4 and 5] – using Leem's original model *and* using the authors' amended (more ICT4D oriented) version of Leem's model in each section. The comparison between measures gained from the original model and the amended model validates the newly added variables – mentioned in section 6.1 – and identifies important key variables for measuring ICT4D project maturity. We pick up on these comparisons and key variables when discussing findings (see section 7).

Our research methodology can thus be described as case study driven and qualitative, with the conversion of interview transcripts and observations into quantitative measures adding measurability and comparability.

5) Case study: The Computer Redistribution Project (CRP)

This case study describes the implementation, growth, and speed of growth of a young grassroots ICT4D initiative started in two different provinces in South Africa. In each of its two implementations, the project entails recycling second-hand computers from within the community at the lowest possible cost to the community (often free), with volunteers from local universities loading free educational content onto the computers, and then redistributing these computers to needful scholars within the same local community. According to the project plan the donated computers will be accompanied by (1) an invitation extended to the recipients of computers to attend additional computer and/or science training at their local university, as well as (2) arrangements for access to additional resources – university library access, university internet access, and access to knowledgeable mentors at the participating universities.

The three primary aims of this grassroots initiative is summarised as follows. First, the project aims to assist scholars who show potential in the field of computer science / IT / Engineering studies (and has made this potential evident through academic work) to attain more frequent, high quality access to computer resources (both at home and at nearby tertiary institutions) and to motivate the scholars towards using this increase in freedom [of access to information] to enhance their academic

work. Second, the project aims towards increasing the possibility of these students finishing secondary schooling with both (i) high enough academic potential and (ii) being sufficiently computer literate to successfully qualify for enrolment for [and hopefully excel at] any technical graduate level course at a local tertiary education institution. Finally, the project aims towards not only increasing the freedom of the few directly benefiting scholars (giving them greater range of study choices, greater earning potential, greater access to information, greater ability to further develop themselves), but to serve as a study of the relationship between ICT4D projects and members of the community and how the community members respond to the new possibilities available to benefiting entities (Krauss, 2010). Do any one of the communities gain enough momentum, or a state of maturity, to allow them to initiate further [socially embedded] development of their students [bursaries for tertiary studies, finding suitable jobs, etc.]? The level of maturity, and factors influencing the maturing speed, of each implementation is measured and discussed in detail in the sections to follow.

The two implementations of the Computer Redistribution Project (CRP) were launched in 2010 and 2011, at two universities in South Africa, with each university servicing scholars from two schools within their geographic proximity. Five promising scholars were selected from each school – using the same basic criteria at each school, giving each university ten scholars to work with, and a total of twenty scholars participating in the first phase of the CRP.

6) Data and measures

In order to measure all the variables of project maturity mentioned thus far - the social embeddedness of the project, the perceived level of social disruption caused by the project, the success of the project in reaching its developmental goals discussed in the previous section, the level of project ownership taken by the community, the presence or absence of direct and indirect increases in freedom, and the influence of social recognition - a diverse set of data was gathered using various [mostly qualitative] techniques, and following the guidelines for interpretive research as suggested by Klein and Myers (1999). The primary focus of the data gathering activities was to gather sufficient data to inform the Five Stages Maturity Model (Leem *et al.*, 2008) used to measure the maturity of a project, and to identify variables that might be used to accelerate growth towards sustainability.

6.1) Initial measures

The first implementation of the project was initiated in January 2010, with 10 students in the Western Province of South Africa each receiving a second hand computer loaded with educational content. The two Western Province schools are coded S1 and S2 throughout the data (empirical, interviews, and observations). A year later the second implementation followed in the Gauteng Province of South Africa, with the two Gauteng schools coded as S3 and S4 in data. The five students at each school were coded A to E, resulting in data coded from S1A to S4E. See table 2 for initial data measures.

Initial measures and interview coding were completed six months into each project and combined into a maturity score for each school, by using Leem's model (Leem *et al*., 2008), without any adjustments. Indicators of maturity as set out by Leem *et al*. (2008) are: vision, infrastructure, organization and rules, support and trust, and application and use, each with an allocated weight. The semi structured interviews used to gather data contained 27 questions covering the indicators mentioned above. Interviewees included school headmasters, involved teachers, and the students participating in the study. Then, using an adjusted version of Leem's maturity model that now included all the variables of project maturity discussed earlier in the article, we measured each community's level of involvement in the grassroots initiatives again, using the same data. Three adjustments were made to the original model: (1) social embeddedness and local ownership were added as a variables influencing maturity of project organization and rules, (2) direct and diffused increase in freedom was added as a variable influencing maturity of project application and use, and (3) social recognition and celebration was added as a new variable influencing maturity, with an initial weight allocated to this new variable after basic statistical analysis of the data.

Using the data to inform Leem's original model and the adjusted model, as shown in Table 2 and Table 3, has two purposes: (i) making sure all the mentioned variables of project maturity are valid, and (ii) testing the validity of the adjustments (additions) the authors made to the model.

Table 3: Initial maturity measurement using Leem's Five stages model (Leem *et al*., 2008)

	Vision	Infra-structure	Organisation and rules	Support and trust	Application and use	Weighted Total %	Maturity stage
Weights:	0.1576	0.1475	0.1472	0.1585	0.3882		
S1	6.00	5.50	3.23	3.00	2.00	35.03	2.25

S2	7.00	6.00	5.23	4.50	6.00	58.27	3.41
S3	6.00	3.00	2.70	5.00	3.00	37.92	2.40
S4	4.50	2.50	2.47	5.00	4.00	38.23	2.41

Table 4: Initial measures using adjusted Five Stages model

	Vision	**Infra-structure**	**Organisation and rules**	**Support, trust, community's relationship with project**	**Application and use, measurable increases in freedom**	**Social Recognition, Celebration, Media**	**Total %**	**Maturity stage**
Weights:	0.134	0.1254	0.125	0.1347	0.3315	0.15		
S1	6.00	5.50	3.23	2.40	1.40	3.00	31.35	2.07
S2	7.00	6.00	5.23	5.15	4.20	8.00	56.31	3.32
S3	6.00	3.00	2.70	4.70	2.40	3.00	33.97	2.20
S4	4.50	2.50	2.47	3.55	2.20	2.00	27.32	1.91

Initial data measures were focussed on establishing the nature and maturity of the relationship between the ICT4D projects and the involved community members.

6.2) Final measures

One year into the project(s), similar measures were taken. Together with the initial maturity measurements from Table 2 and Table 3, these measures were used to measure the growth and speed of growth in project maturity. Data from interviews were again coded and combined into a maturity score using Leem's original model, and then the adjusted model – see Table 4 and Table 5.

Table 5: Final maturity measurement using Leem's Five stages model (Leem *et al.*, 2008)

	Vision	Infra-structure	Organisation and rules	Support and trust	Application and use	Total %	Maturity stage
Weights:	0.1576	0.1475	0.1472	0.1585	0.3882		
S1	4.50	5.50	3.23	3.00	2.00	32.67	2.13
S2	7.00	6.00	5.23	5.50	6.00	59.85	3.49
S3	6.00	4.50	3.87	5.00	3.00	42.59	2.63
S4	3.50	4.00	2.47	3.50	4.00	36.49	2.32

Table 6: Final maturity measurement using adjusted model

	Vision	Infra-structure	Organisation and rules	Support, trust, community's relationship with project	Application and use, measurable increases in freedom	Social Recognition, Celebration, Media	Total %	Maturity stage
Weights:	0.134	0.1254	0.125	0.1347	0.3315	0.15		
S1	4.50	5.50	3.23	2.40	2.30	3.00	32.33	2.12
S2	7.00	6.00	5.23	5.65	5.70	8.00	61.96	3.60
S3	6.00	4.50	3.87	5.30	4.80	7.00	52.07	3.10
S4	3.50	4.00	2.47	2.65	3.10	2.00	29.64	1.99

7) Findings and suggestions

In this section we draw on the data measures discussed in the previous section and confirm the findings of previous studies in literature. We expand on these findings with our own regarding:

1) The relationship between local ownership and project maturity/success

2) The relationship between recognition [and celebration] of achievement and project maturity/success

3) The relationship between increases in freedom and project maturity/success

4) The relationship between local ownership and increase of freedom(s)

5) The relationship between local ownership and social embeddedness

7.1) Local ownership, control and ICT4D project maturity

The seminal research question of this article is worth revisiting. How can ICT4D project be grown towards maturity, making them sustainable? When can foreign investment start withdrawing their support without jeopardising the project's chances of success? From literature we've gained that active participation from locals in development projects, including ICT4D, with a focus on local management and integration of these projects into local social structures are steps in the right direction – towards communities developing in a sustainable way.

We confirm the importance of local ownership in project maturity with the data from our case study. Forming part of our measurement of "support, trust, and community's relationship with project", local ownership weighed only a few percentage points of overall maturity. In our final maturity measures – see Table 5 – school S2 showed signs of moving towards level 4 maturity, which is characterised by local ownership and control (Leem *et al*., 2008). This observation is valid as S2 is the only school in the case study that has started showing signs of having a relationship of ownership with the project. This relationship between ownership and project maturity confirms that this is an important indicator of sustainability, as stated in extant literature, and may deserve a greater weight after a re-evaluation of the maturity model. Practical experience gained from active participation in the case study project leads the authors of this article towards the same conclusion. The findings of Parkinson (2005) and Pade-Khene *et al*. (2011) speak of similar experiences.

This brings us to our second –significant and refreshing – finding. Literature poses an indirect question regarding project ownership. How can local ownership of projects [and thus sustainability and maturity] be stimulated or accelerated to the point where foreign ownership can be discontinued? This question guided our research towards questioning the importance of social recognition [and celebration of achievements] in the motivation of ownership.

7.2) Social recognition of achievements related to ICT4D projects

Literature gives little insight into the role of media recognition and public celebration of ICT4D related achievements. When mention is given, it is in a negative light (Chigona & Mooketsi, 2011).

The relationship between ICT4D project sustainability (including the speed with which a project reaches a state of sustainability) and the level of social recognition given to participating community members was found to stand out from initial data measures and further interpretive investigation proved fruitful. Two of the four involved headmasters and two of the involved computer science teachers clearly stated their interest in further recognition from universities and other authorities for their involvement with the ICT4D project. Social recognition in the form of certificates, photos, and a publicly accepted affiliation proved not only highly motivational to the local owners of the ICT4D projects (headmasters and teachers), but also to the benefitting students. One student suggested wearing a collar pin in order to confirm his status as a university representative within the community.

In order to test the validity of this finding, more data will have to be gathered. In the interim the authors did embark on a small-scale experiment, staggering the social recognition given to participants at each of the four schools over time. The social recognition for school S1 and S4 – certificate ceremony at school, training and mentorship by university representatives, media publicity – was placed on hold for a few months, while allowing these activities to continue and accelerate at schools S2 and S3. Even with this severely limited data set, the results are already nearing significance – see Table 5.

The weight allocated to the social recognition variable within the adjusted Five Stages Maturity model, described in the previous section, is another point of debate – an initial weight of 0.15 was given as this is a close approximation of the average weight given to variables in the original maturity model by Leem *et al*. (2008). The authors acknowledge the lack of available data on which to base this weight, and, now that initial data measures are available, suggest a more rigorous model validation through regression analysis.

7.3) An increase in freedom and ICT4D project maturity

Revisiting our introductory definition of development (section 1.1), we state again that it must be possible to tie any proposed development back to a measurable direct or indirect increase in freedom for our definition of development to be satisfied. This definition is strongly supported by our findings that an ICT4D project only becomes sustainable, and hence result in sustainable developmental outcomes, when a visible, measurable *diffusion* of increases in freedom has taken place. Direct increases in freedom, such as greater access to information via the internet, can be identified while a project is still growing through stage 1 of the maturity curve. At such a time, the project is neither sustainable nor able to handle the withdrawal of external resources.

Our case study indicates that, even when a measurable *direct* increase in freedom becomes visible during the early stages of ICT4D, the project cannot survive on its own momentum. The authors, at the time also acting as the primary resources for the project, tested this finding by giving no input to any participating community members for three months. Project maturity stopped growing. In the case of school S4, maturity actively decreased during this time as the community self-admittedly forgot about the participating students' involvement with the project and gave them no support.

Our case study also provides the first available contextual data for suggesting that a project can be deemed mature when a measurable diffused increase in freedom can be observed. From our data, schools S2 and S3 showed observable signs of diffusion. At both schools the participating students made their computers available to other students, to their benefit. At school S2, the computer science teacher used two of the computers to facilitate lectures on computer hardware, and the installation of various operating systems. At school S3, the schools involvement with the initial ICT4D project has made other needs public, and the school's computer lab is currently undergoing an upgrade initiated by university students that became involved due to the original ICT4D project.

A suggestion that is aligned with Sen's work on diffused increase in freedom (Sen, 1999), is that these freedom diffusions serves as indications that development is taking place and that the development process has reached a higher level of maturity. We suggest that freedom diffusion indicates an acceleration towards project maturity.

7.4) Local ownership and an increase in freedom

The relationship between the previous three findings can be stated as follows, giving a validated answer to our research question.

A diffusion of development potential and developmental benefit – being a sure sign of a project accelerating towards maturity - will only happen *after* members within the benefiting community take local ownership [control] of the ICT4D projects in their community and the rearrangement of social structures required by these projects (level 4 maturity leading to level 5 maturity). The local ownership stage can be *accelerated towards* by giving (context sensitive) social recognition and media publicity to participating community members, focussing on ICT4D related achievements.

7.5) Local ownership and the epistemological embeddedness of ICT4D projects

Throughout two years of active participation in the mentioned case study, the work of Avgerou (2009) regarding the social embeddedness and perceived level of social-structure disruption of any ICT4D project has proven fundamentally sound. Being a project that was, at least initially, poorly embedded and epistemologically foreign, the CRP encountered several barriers to development directly linked to the fact that most of the resources and management originated outside the involved communities. We agree with Avgerou (2009) that socially embedded projects reach maturity and sustainability *faster*. As the relationship between local stakeholders grew, and the development potential of the project became clearer to participating community members, local ownership started taking shape, which in turn triggers an accelerated move towards maturity.

7.6) Diffused increase of freedom, social integration and project maturity

In Leem's Five Stages Maturity Model (Leem *et al*., 2008), the final stage of maturity is called *integration*. Indicators of integration include clearly visible local ownership and the project being a fully functional, accepted part of the community's social structure. As mentioned in our literature review, social momentum plays an important role in transforming social structures to this degree.

Another indicator of a project reaching the final stage of maturity is, according to Leem *et al*. (2008), the project being able to handle changes in its environment. We cannot confirm this finding from our research, as the CRP is still a maturing project, but we suggest that external [foreign] resource investment can only be withdrawn from the project when a project clearly portrays this characteristic – being able to *manage change locally*. This agrees with key ICT4D success factors mentioned in literate (Pade-Khene *et al*., 2011).

8) Conclusion

It is possible for ICT4D projects to reach a maturity stage where a withdrawal of non-local investment (donor funding) will not cause the project to fail. This maturity stage is characterised by

local ownership, rearranged social structures, and both direct and indirect increases in freedoms experienced by involved community members.

One student participating in the case study project suggested acquiring more second hand computers from local businesses, and she volunteered to administrate the process using her newly acquired second hand computer. Another student confessed to using his computer to assist a fellow pupil with fixing their home computer. It is small indications such as these that validate ICT4D projects and the substantial initial resource investments needed to launch such projects. It also validates external (non-local) involvement until a satisfactory level of maturity has been reached (at least stage 4 maturity).

The project discussed in the case study has barely reached half way on the maturity curve, and is only slowly gaining momentum. It is critical not to label such projects as failures before they have been given a fair amount of time to mature. If all external resources were to be withdrawn from the project at such a time due to it being branded a failure, all visible development potential will be lost, as the project has not reached a point where it is sustainable and robust enough to manage such a major change in its environment. As suggested in our findings, the project can be accelerated along the maturity curve through positive social recognition and a focus on increasing the level of epistemological embeddedness of the project.

ICT4D projects all aim towards sustainable developmental outcomes, helping communities grow (and continue growing) by using ICT. To ensure sustainable ICT developmental outcomes, literature suggests that a project must be able to run on local resources and local motivation. For a project to run sustainably on local resources only, enough community members must buy into the potential development proposed by the project. Community members become involved only when they witness achievements and measurable benefits directly or indirectly related to the project or when they are given public recognition for their participation. In economic terms, community members only become involved in ICT4D if they gain utility or direct benefit from the engagement. Indirect or diffused benefit derived from projects seem especially helpful in including peripheral community members, getting them involved in projects, and drawing them towards direct benefit.

In this chapter we discussed the importance of pursuing diffused increases in freedom when growing an ICT4D project towards sustainability, as these increases are sure indicators of increases in the utility of community members. We also found indications that social recognition and a positive use of media coverage can be used to accelerate a project along the maturity curve – this finding might

also be linked to increased satisfaction [utility] of community members. Both these findings are new additions to ICT4D literature and require further research before being included in accepted project maturity models.

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4.3 End Notes – Part 1

In the introductory chapter of this thesis we mentioned the pervasiveness of some research interests and philosophical nuances throughout this study. We now make some observations in this regard.

4.3.1 The influence of the media on project success

The effects of media coverage and social recognition on the success of ICT4D projects were discussed in this section. Media exposure seems to appeal to community members on a social level, and attracts community members towards involvement in development projects. Media coverage, it would seem, promotes local ownership.

4.3.2 Socio-economic history and project success

Throughout this first part of the study, the researcher tried to stay away from prematurely linking the failure of a development initiative to the political or socio-economic history of the developing community. An example is in order. It is easy to assume that a lack of student internet access at the CRP target schools is the result of a lack of infrastructure, which in turn is the result of the community/school's economically challenged past. Only when it was found that all the schools that listed internet access for students as a problem actually *had sufficient internet infrastructure and access installed*, but that the staff did not know how to make the internet available to the students in a sustainable, responsible way, did the researcher realise how wrong such an assumption would be. Furthermore, the proficiency of students in using mobile phones to access the internet was observed, with some students being more capable in this regard than others. As a result of these observations, the focus of data gathering activities was on the individual capabilities of students and staff members – following the capability approach as discussed in the Introduction of this thesis. The success of ICT4D projects, as pointed out in this chapter, seems to be built on the capabilities and buy-in of individual community members, rather than the perceived (historical) economic capability of the community as a whole. This does not mean that the researcher does not acknowledge the difficulties faced by poor communities – it means that development project failure cannot be ascribed to these difficulties without solid grounds, which will often point back to individuals (lack of knowledge, lack of ownership, lack of social motivation) as being the cause of project failure. As the focus now shifts from infrastructure development projects towards education-based development projects in Part 2 and Part 3 of this thesis, it is noted that the socio-economic conditions of the developing group/community is a variable that should be part of data gathering activities as this

study progresses, but that it has by no means been proven as a significant variable for the final framework – a framework for increasing enrolments and graduates through education-based, focussed IS development projects. This variable will be mentioned several times during the data analysis in Part 2.

4.3.3 Development as increases in freedom

The chapters to follow builds on the concept of development as an increase in an entity's capacity [capability] to do the things it deems important – an increase in an entity's freedom. If freedom has not increased measurably, then, by definition, no development has taken place. The importance of this underpinning definition of development becomes clearer as the study progresses – a student who has received education in skills that s/he will not use in an industry or community context has *not* been developed – the student's freedom has not been increased. There are no measurable direct or diffused increases in freedom resulting from such education projects. The researcher returns to the variable of measurable diffused increases in freedom in Part 3 and Part 4, when he measures the impact of education-based IS development projects in the mobile application development domain.

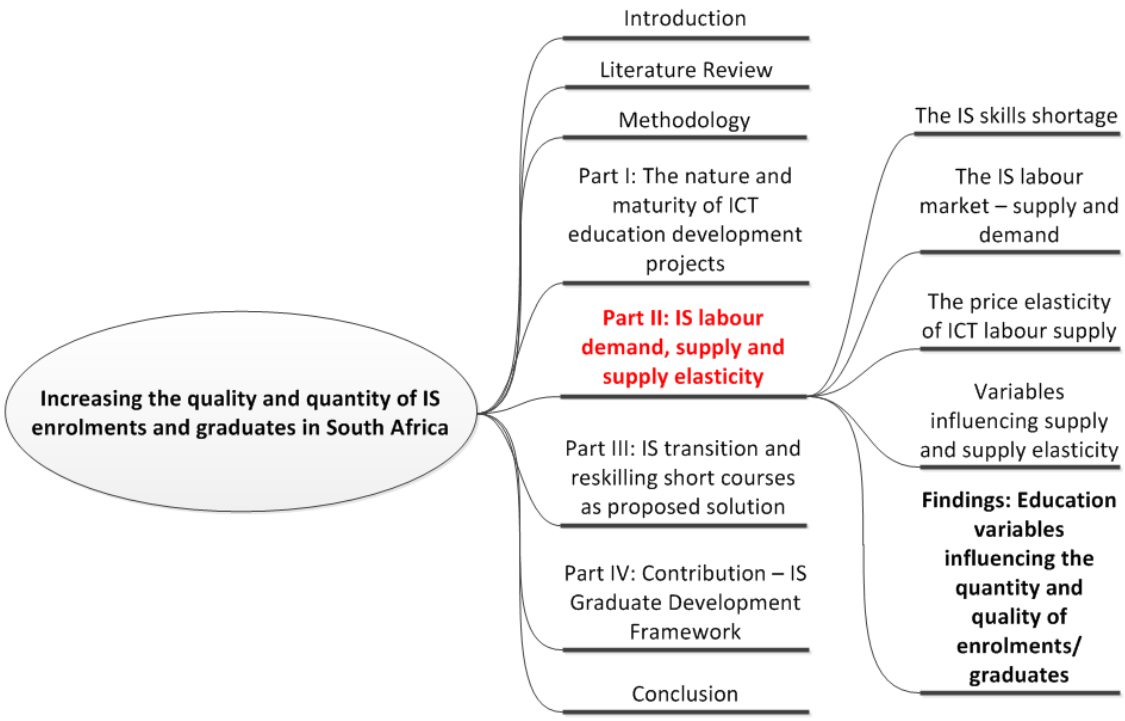
4.3.4 Maturity models for ICT development projects

A large part of this chapter was spent informing an existing maturity model with social variables so that this adjusted model could be used for ICT4D project success measurements. Although the adjusted model was found useful and able to describe ICT project maturity with a high level of accuracy, the researcher acknowledges that this model will have to undergo further development if it is to be used for something other than the measurement of infrastructure-based ICT development projects. The model is a valuable secondary output of this study, and an opportunity for further research.

4.3.5 Appendices

A summary of the data gathered for this part of the study is available in Appendix 1.

CHAPTER 5: PART 2 – SUPPLY ELASTICITY WITHIN THE SOUTH AFRICAN ICT LABOUR MARKET



5.1 Introductory notes

> *"Even though the operation of the market economy can be significantly defective ... nevertheless there is no way of dispensing with the institution of markets in general as an engine of economic progress. Using markets is like speaking prose - much depends on what prose we choose to speak." – Amartya Sen – Interdependence and Global Justice (2004)*

Part 1 of this study helped us to understand social factors that influence development projects. Conceptually, the researcher now had a clearer view of the type of project that could facilitate the increases in the quality and quantity of IS enrolments and graduates he was striving to achieve. At this point in the study the researcher also had incorporated into the study (i) a definition of development that promotes measurability, (ii) the concept of having reached maturity when diffusion of development potential becomes evident, and (iii) indications that long-term social relationships serve as motivators for social choice [such as study and career choices].

In an independent, informal interview with the retired manager of one of the largest infrastructure-based ICT development projects in South Africa's history[12], the Khanya Project[13], which served nearly 1 500 local schools with computer rooms, infrastructure projects and education-based projects were informally weighed against each other according to their graduate development potential. The result was a hypothesis [not a finding] that education-based projects have a distinct advantage due to the relationships they build, and their ability to match student potential with market demands.

5.1.1 Moving from Part 1 to Part 2

This feeling that a solution to the IS skills shortage could be found on the education side of development, not necessarily on the infrastructure side, became pervasive in several informal discussions resulting from Part 1 of the study. This hypothesis was later reinforced – in the concluding sections of Part 2 – by the findings from a large-scale survey – education-based projects, if designed with Part 1 in mind, could stimulate an increase in graduate numbers. The findings in Part 1 helped to shape the researcher's ideas regarding the type of education-driven projects that should

[12] Kobus van Wyk, Head of e-Learning Initiatives at Mustek Ltd: za.linkedin.com/pub/kobus-van-wyk/b/a10/69

[13] The Khanya Project website was discontinued in 2012. Read about the project online at http://curriculum-dev.wcape.school.za/

be designed as potential solutions to the skills shortage: long term, with a community focus [tailor made], with local institutions taking ownership, enough social recognition, and bringing in a competition feel. These thoughts helped in structuring the questionnaire [data gathering activities] for this second part of the study, Part 2. The reader will recognise these variables when they are used in the supply-side model created in the later part of this chapter.

The concept of supply elasticity within labour markets might be foreign to the reader. In the Methodology and Research Design chapter, the basic economic premise behind the discussion of IS labour supply elasticity was explained, as well as how the research in this chapter was designed to find variables that could increase supply elasticity. It is through increases in IS labour supply elasticity that the harsh effects of the current IS skills shortage on core IS industry sectors can be tempered [the production possibility frontier can be moved], while overall supply is stimulated. Based on the mentioned discussions with industry stakeholders and findings from Part 1, industry-teacher and industry-learner relationship-building education-based development projects at all levels of the IS labour supply chain were hypothesised as a way of increasing IS labour supply elasticity. Suggestions from the literature (Alexander *et al*., 2011; Alexander & Twinomurinzi, 2012) were used to translate this need for a more elastic graduate supply into education-based variables. See Figure 8 for a visual presentation of how Part 2 follows conceptually on Part 1, and builds towards the argument regarding short transition and reskilling courses in Part 3.

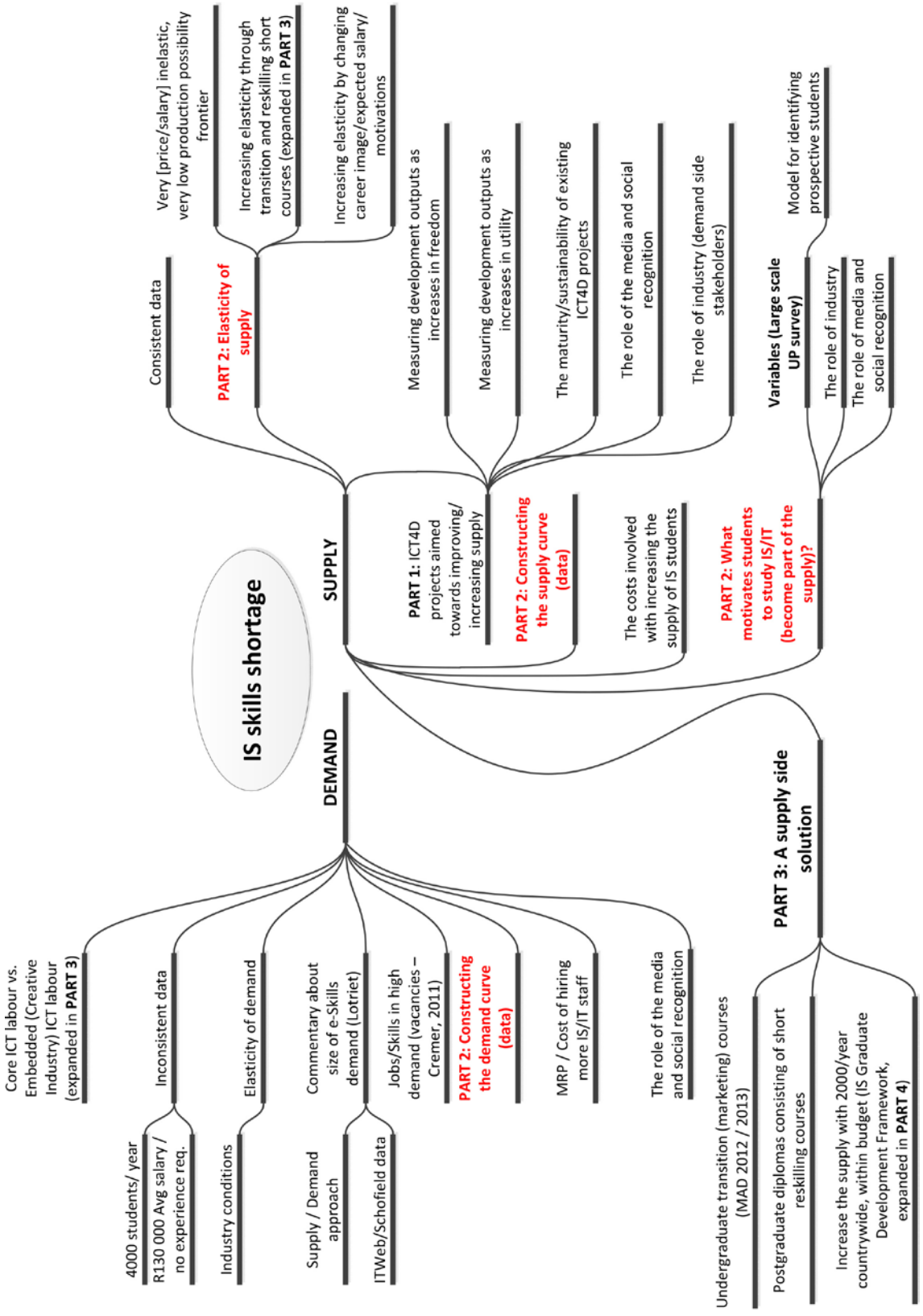


Figure 8: Moving from Part 1 to Part 2 of the thesis

5.2 Article

Breytenbach, J., & De Villiers, C. 2012. Supply elasticity within the South African ICT labour market. Proceedings of the Fifth Annual Pre-ICIS Global Development Workshop, Orlando, Florida, 2012. Available online: http://goo.gl/6gZNp

Supply elasticity within the South African ICT labour market

1) Abstract

Creating a sufficient, sustained supply of tertiary level ICT skills at graduate level to stimulate growth in the developing South African economy is an important concern for all stakeholders involved in the South African ICT labour market. This article furthers the discourse on the much discussed ICT graduate shortage in South Africa by presenting a neo-classical labour market analysis of the demand and the supply of scarce skills ICT graduates in South Africa, validating the existence of a shortage through labour market theory, and then exploring the validity of variables influencing the supply side of this ICT labour market.

Reports describing South African ICT skills supply and demand are readily available[14], but the consistency and accuracy of these figures have been questioned (Lotriet, Matthee, & Alexander, 2010) Presenting the available data using labour market supply and demand curves provides another angle of approach to this data and an opportunity to validate the existence of a skills shortage (if it exists), as well as reasons for such a shortage. This neo-classical labour market view of the South African ICT skills deficiency is enriched with a discussion about the elasticity of supply within the South African ICT labour market. Findings from this section of the study includes the tendency of an increase in scarce labour supply to trigger further increases in demand for such skills through an increase in capital investments within the scarce skills sectors, causing a yearly supply shortage to remain until capital investments reaches profit-maximizing equilibrium.

[14] As example, see 2011 figures published by the MICT SETA at http://www.mict.org.za/downloads/Isett_Seta_Sector_Skills_Plan_2011_2016_Jan_2011_Version_v2p1.pdf

In the latter part of this article we investigate variables that influence the elasticity of supply within the ICT labour market using a large scale survey of tertiary students. Ways of (i) increasing the elasticity of ICT graduate supply and (ii) increasing the overall ICT graduate supply level through the manipulation of these variables are discussed. Findings include, amongst others, the importance of long term relationships (with well-informed parents and teachers) as primary motivator for tertiary ICT study and the importance of industry informed (demand driven) ICT related subjects at secondary school level as motivation for tertiary ICT study. The match between ICT skills being supplied and demanded also receives mention as part of this conceptual ICT labour market analysis.

Keywords: e-Skills shortage, ICT labour market in South Africa, ICT education, IS education

2) Introduction and problem statement

This article discusses the South African ICT skills shortage and ways in which the ICT skills market can be made more effective from a human capital perspective.

A generally accepted proposition from neoclassic human capital theory states that investment in the education of labour increases the productivity, and hence the output, of a workforce. Stated differently, education increases human capital, and increased human capital results in higher productivity. Increased productivity and output, in turn, supports economic development (the existing workforce is more productive and better equipped for work, making new levels of efficiency possible). Cross-industry analysis of this human capital approach has found it to apply, not without criticism, to technology and innovation labour markets as well (Toner, 2011). From within this generally accepted position, we assume as starting position for this study that investment in the education of ICT graduates will stimulate economic growth in South Africa. This economic growth includes greater capital investment in the ICT sector.

The South African ICT industry, employing professionals with skills including basic e-Skills, software development skills, and Information Systems (IS) skills such as business analysis and systems analysis, have been identified as an industry that is not contributing enough towards economic development in South Africa, especially through ICT education and training[15]. The ICT industry's response to this critique often includes mention of the country-wide ICT skills shortage as a reason

[15] Trialogue 2010. The CSI handbook, 12th Edition.

for the industry's lack of performance. The role of industry in ICT education and training is an important secondary question within the ICT skills shortage debate, and receives frequent mention in this article.

According to much debated surveys (for a summary of this debate, see Lotriet *et al*., 2010) there is a shortage of ICT professionals in South Africa. This shortage, if left unchecked, may hinder the country's economic development, and cause South Africa to fall behind in global ICT development trends (Merkofer & Murphy, 2009). This statement is supported by the abovementioned human capital view of labour markets. The authors of this study agree that an increased supply of ICT professionals can stimulate economic growth in South Africa by stimulating capital investment in ICT ventures. The problem statement of this article revolves around ways of increasing the supply of ICT professionals in South Africa so that accelerated economic growth can be achieved – growth that is not limited to the ICT industry, but rather a diffused growth within all the ICT reliant economic functions in South Africa.

The reported ICT skills shortage in South Africa (and its effect on industry growth) is difficult to analyse (Calitz, Greyling, & Cullen, 2010; Lotriet *et al*., 2010), with reasons for the proposed shortage varying from fast changing industry demands to a lack of standards in defining ICT careers and the parts of tertiary curricula they relate to (Calitz *et al*., 2010). Data indicates a seemingly clear and agreed upon shortage in graduate level software developers and business analysts (Cremer, 2011; ITWeb, 2011), and yet the extent of and reasons given for this skills deficiency are hard to validate (Calitz *et al*., 2010).

This article provides another presentation of recently published data in the form of a supply and demand curve for scarce graduate level ICT skills, including software developers/engineers (and mobile application developers) and business analysts. The agenda behind presenting the data using this typically neoclassic economic approach is threefold: (i) to place the South African ICT skills shortage dialogue within the boundaries of neoclassic labour market and human capital theory in order to discuss the effects of education-stimulated increases in the supply of scarce skill labour, (ii) to start a discussion regarding the elasticity of supply in the South African ICT labour market, and (iii) to validate a detailed look at variables influencing supply and elasticity of supply within the South African ICT labour market.

Following a similar approach as recent studies on this topic (Lotriet *et al*., 2010) this article focussed on tertiary level graduate supply and demand of ICT skills, and not on the full spectrum of ICT skills, often referred to as e-Skills.

This paper is structured as follows. First, a short literature overview of the South African ICT skills shortage debate is provided. Second, we present the supply and demand curves for the mentioned scarce ICT skills in neo-classical labour market fashion. Third, we discuss the elasticity of ICT graduate supply. Fourth, variables are identified that influence the supply side of the ICT market, and a model for identifying potential ICT graduates are constructed. Fifth, we test and validate this supply-side model with a large scale survey (4475 students). Finally, we discuss the findings from the survey in the light of supply elasticity and suggest ways of increasing the level of supply (and elasticity of supply) of ICT graduates in South Africa.

3) Literature Background

3.1 The ICT skills shortage in South Africa

This study joins the ICT skills shortage debate during 2011-2012. During this time the South African government institution responsible for ICT skills development, the Media, Information and Communication Technologies Sector Education and Training Authority (MICT SETA), published ICT skills shortage statistics based on information gathered from industry partners (companies registered as members of the MICT SETA), for the period 2009 to 2011 (MICT-SETA, 2011). An extract from this publication is presented in Table 7.

Career/Job description	Shortage (Registered vacancies within ICT industry and other industries)
Business Analyst	299
Systems Analyst	362
Web Developer	51
Analyst Programmer	52

Software Developer / Programmer / Engineer	572
Security Specialist	63
Systems Administrator	175

Table 7: MICT SETA ICT skills shortage figures published in 2011

Positive characteristics of the MICT SETA data include (i) it being informed by a large scale industry survey (ITWeb, 2011) and industry partners, (ii) the data being verified using trend analysis over a longer period of time – three years, and (iii) this (demand side) data being measured against validated national graduation figures (supply side data), if only at a very basic level. Criticisms of this data and its validity include (a) yearly data being based on faulty, or inflated, historical data, (b) the data not matching with other large scale studies and media reports, and (c) the data being flawed due to a lack of industry standards for the classification of ICT careers. Overlooked points of concern that can be added to the list of criticisms are the MICT SETA report's mention of both an oversupply of diploma level students and the high percentage of ICT graduates that are not South African citizens and will possibly put their skills to use outside the South African ICT labour market (causing the shortage to be incorrectly presented) (MICT-SETA, 2011, p. 47). For a critique of the MICT SETA data, as well as other data sources, see the contribution by Lotriet *et al*. (2010). For a detailed mention of other data sources often used to justify statements within the ICT skills shortage discourse, see the Calitz thesis (Calitz, 2011).

The shortage of two skills seem to be agreed upon in literature: (1) Business Analysts, and (2) Software developers – particularly scarce programming skills include graduate level Java and C#, and C#.Net skills. Graduates that are capable of combining these scarce programming skills with basic SQL skills are even harder to find. A recent large scale skills survey (ITWeb, 2011) hints at a third core skill soon to be added to this list, (3) Mobile Application Development.

To summarize, there seems to be agreement on the existence of an ICT skills shortage within literature and industry, and even the nature of the shortage (which skills are needed most and how they can be produced), but literature includes conflicting reports [views] on the magnitude of the shortage and the (seemingly minimal) effect that skills-increasing projects have had on the ICT skills deficiency over the last five years. It is to this end that we approach the data from a labour market perspective.

3.2 The ICT labour market in South Africa

Recently (Merkofer & Murphy, 2009), the South African ICT skills shortage was conceptually placed within an economic "supply and demand" context, as writers confirmed the South African ICT industry's poor economic development performance based on international ICT industry benchmarks. According to education-focussed development benchmarks, "South Africa lags heavily behind Finland, India, Ireland, Vietnam and Mexico" (Merkofer & Murphy, 2009). Joining in on the economic approach to the discourse (Calitz *et al*., 2010), the South African ICT graduate supply was seen by writers as a "supply chain" and critiqued as such. No labour market theory was used to analyse the interaction between the supply and demand of graduates or the elasticities within this market – *how, and how fast* the market would react to increases in either the volume or the price of labour supply.

Toner (2011) summarizes the application of human capital theory to the field of "innovation skills development" as follows:

> *"Firstly, 'human capital' is regarded as analogous to physical capital, in that increased 'investment' in labour, especially through education and training, improves the productivity of labour. In other words, human capital is one of the prime determinants of labour productivity. Secondly, improving the quality of labour through education and training* ***increases the complementarity between labour and capital****. Higher-quality labour raises the productivity of capital,* ***stimulates further capital investment****, and hence raises the demand for skilled labour"* (Toner, 2011, emphasis added).

From this human capital perspective of the ICT labour market, we learn from Toner that an increase in investment into labour supply (via education and training initiatives) will increase the supply and the quality of the supply. This will, in turn, increase the demand for the same skills because of greater capital investment in the affected (scarce skills) industries. This plausible chain of events, where not without critique, differs from classic labour market theory. In a classic labour market analysis there is no skills shortage as all skills are readily available at all levels of income and increased supply (or increased quality of supply) results in no change (or even negative changes) to the level of demand. We will further discuss this important concept of "increased demand as a result of increased supply" in the section called "The supply and demand for ICT skills in South Africa".

The human capital perspective mentioned above can be seen as a theory that opposes the economic labour market theory of *signalling*. A comparison between signalling and human capital theory is

beyond the scope of this article. The authors of this article acknowledges this as a limitation of this study and agrees that signalling as a theory can provide valuable answers towards the problem statement of this article.

3.3 Variables influencing ICT graduate supply / elasticity

Our literature review now moves on to the foundation for the latter part of this text, where our focus shifts from a presentation and validation of the magnitude of the South African ICT skills deficiency to an analysis of the variables influencing the supply of ICT graduates in South Africa. A western example of a similar discussion (Walstrom, Schambach, Jones, & Crampton, 2008) that looked at motivations for students to choose ICT as study focus and, eventually, a career – mentions the following variables as important when measuring the popularity of ICT as study or career choice:

- The role of parents and teachers in students' study/career choices
- Understanding of various industries (as potential working places)
- Understanding, having knowledge of, specific career descriptions
- The public/media image of careers/industries
- Marketing approaches of different industries

These variables, amongst others, and their influence on the supply of graduate level ICT students are investigated and discussed later in this article in section 6. We present a statistically tested model that shows the importance of each variable on a student's choice of study/career path.

Our discussion regarding these supply side variables within the ICT labour market, and the model we construct to measure these variables, might cause the reader to become confused about the primary argument of this article. Therefore we mention again at this point the assumption of the labour market theory underpinning this study:

An increase in the ICT graduate supply (and/or quality of supply), through education and training, will have a positive influence on the growth of the ICT industry through stimulating capital investment. Conceptually this will then contribute to South African economic development. Our aim is towards *education-driven economic development*, and not towards the production of another theoretical model for predicting the career choices of students. We want to stimulate economic growth by increasing the efficiency of the ICT labour market through education.

Before we continue with the contribution of this article, we add one final disclaimer. Influencing ICT labour supply side variables will inevitably take the form of "ICT-education focussed projects", for example projects that influence the long term career motivation of students towards a career in ICT, or projects that increase the number of students that take Computer Application Technology as a secondary school subject. We have to deconstruct ICT supply to this basic level where we have variables that we know how to influence through education or institutions for this study to have a practical impact. For a more complete analysis of the character of education focussed ICT for Development (ICT4D) projects that aim towards increasing the supply of ICT skills in South Africa, and how such projects can be accelerated towards sustainability, see the researchers' related work (Breytenbach, De Villiers, & Jordaan, 2012). It is also for this reason – change in the supply side of the ICT labour market being *education project driven* – that this article concludes with a short, practical discussion about how such skills-supply-increasing projects should be structured [approached] by stakeholders from both the supply side and the demand side of the market.

4) The supply and demand for ICT skills in South Africa

In this section the authors attempted to construct a supply and demand curve from the (limited) MICT SETA data mentioned earlier, informing the available data with two investigations of their own[16]. The result is presented in Figure 9[17].

[16] Reviewed CareerWeb statistics for software development, business analysts and mobile developer vacancies 2008-2012, and the ICT vacancies survey done by Cremer (2011).

[17] At the time of writing, R1000 (ZAR – South African currency) equalled $122, or €96.

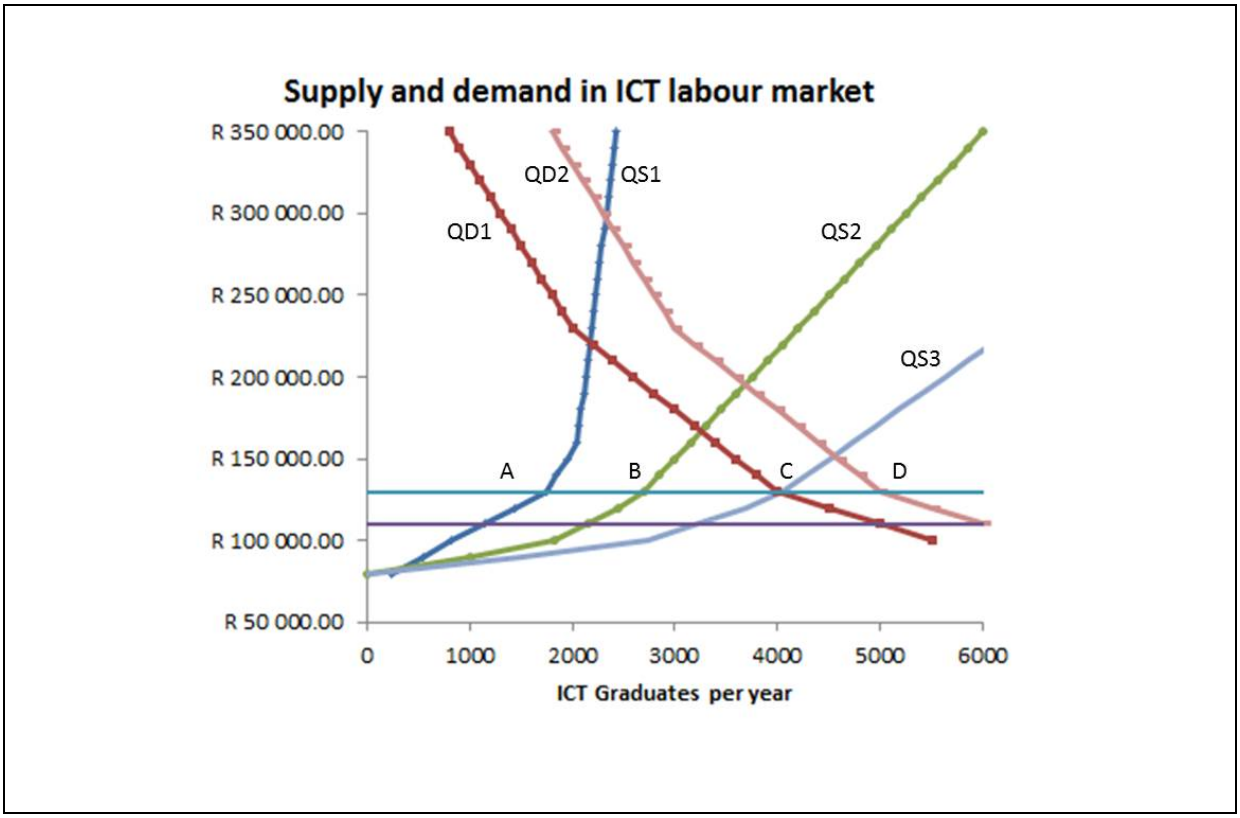


Figure 9: Constructing supply and demand curves for the ICT labour market

Currently the South African ICT industry is functioning on supply curve QS1 and the demand curve QD1. Major characteristics of the current ICT labour market situation are (i) supply drying up almost completely at around 2000 graduates per year, regardless of the salary offered (price-inelastic) , (ii) industry taking in about 1750 graduates each year at an average salary of R130 000 per year – where QS1 intersects the average salary line [point A], and (iii) the industry reporting a shortage of about 2200 graduates a year at the current average graduate salary level, indicated by the intersection of QD1 with the average salary line at about 4000 graduates [point C]. This position can be supported from MICT SETA and ITWeb data. Labour supply curves often take on inelastic shapes similar to QS1, indicating a production possibility frontier – the current maximum labour supply in the market. If this production possibility frontier [2000 graduates per year] is less than the current demand at expected salary [4000 graduates per year], there is a labour shortage in the market.

In order to answer the problem statement of this article, we now analyse the effects of a hypothetical education-driven increase in the supply of graduates. If an increase in supply can be engineered [this is the focus of the latter part of this article] so that supply moves to QS2, where supply is higher and more readily available at all salary levels, the immediate shortage of new graduates will become smaller as the distance between the intersection of the supply and demand

curves with the average salary curve becomes smaller [point C – point B]; we now see a yearly shortage of less than 1500 graduates.

At this point we can easily oversimplify the analysis by suggesting a targeted yearly increase of about 2000 ICT graduates (through education and training initiatives), and feel justified in our assumption knowing that 2000 graduates per year is an attainable target when the responsibilities, and costs, of this increase in supply are divided between several tertiary institutions. We would however be in error if this was our conclusion, and very surprised when the MICT SETA again publishes data that reports a shortage of more than 2000 graduates per year! The reason for our error would be an oversight of the labour market theory that states an increase in scarce skills supply will cause an increase in the demand for those scarce skills by stimulating capital investment in the scarce skills industries (Toner, 2011).

According to this theory, the demand curve QD1 would also move outwards, say to QD2, as supply continues to increase through QS2 towards QS3. We now see a very realistic position where the supply of an additional 2000 graduates per year has caused an increase in demand of a further 1000 graduates per year. The move from QD1 to QD2 happens as more skilled labour in a growing industry causes the industry to expand through capital investment as companies try to maximize the profits they are generating by producing more income per additional employee than the average salary of each additional employee – Toner refers to this as “the complementarity between labour quality and capital investment” (Toner, 2011). A monetary concern that makes this position appealing to graduates is the likelihood of them earning well above the average expected salary, leveraging the skills shortage that still exists (and will remain as the industry expands), and taking advantage of the higher expected salary levels associated with a higher demand curve. This stability in salary expectation makes ICT a more secure career choice in that the market is still some years away from supply saturation. Non-monetary factors supporting this market position include increased mobility of ICT labour supply as more graduates become available (this will increase the elasticity of supply and prevent the “drying up” of supply as demand increases) and a lower level of risk being associated with the ICT labour market, both from an employer and employee perspective.

If we then, to summarize this section, follow this cycle of events through a complete year, we end where QS3 now intersects QD2, still well above the average salary line, meaning there is still a profit to be made for industry, and reason for supply and demand to grow further. A shortage still exists (the distance between point C and D on the average salary line), and this small [consistent] shortage

is to be expected in the light of our discussion above. According to this view of the available data, there is an ICT skills shortage in South Africa, and the shortage will remain for years to come.

5) The elasticity of supply in the ICT labour market

We now turn our attention to the concept of supply *elasticity* in the ICT labour market. In this section we describe the concept of *elasticity* and motivate why increasing the elasticity of ICT graduate supply is an important concept when discussing how to approach the ICT skills shortage in South Africa.

In Figure 9 we see not only the level of supply increasing from QS1 to QS3, but also the shape of the supply curve changing – becoming more horizontal with a more moderate gradient. This change in shape indicates a change in what economists term the "price elasticity of supply" – how sensitive the supply [of ICT graduates] is to a change in price, or in this labour market scenario, a change in expected salary. A moderately elastic supply, such as supply curve QS3, indicates a measure of fairness [competitiveness] in a labour market – a position where companies cannot attain labour too far below the average salary and labourers cannot expect wages too far above the average salary rate. Moderate supply [price] elasticity in a labour market moves the intersection of the supply curve and the average salary line much closer to the intersection of the supply and demand curve – the point of optimal profit and efficiency within the market. From a development economics or welfare economics viewpoint, this is our goal: to increase supply and the elasticity of supply until we have eliminated inefficiencies from the labour market and have the supply and demand curve intersect each other on the current [realistic/internationally competitive] average expected salary line.

Increasing the elasticity of the supply is, according to the authors, at least as important as increasing the level of supply, **as this increases the profitability for companies in the market, the attractiveness of the market for graduates (from a salary and industry risk point of view) and, by definition, moves the labour market to a more efficient, competitive state.**

If we work with the supply curves constructed in Figure 9, the measurement of the price elasticity of supply (PEoS) for the South African ICT labour market can be calculated as follows:

PEoS = (% Change in Quantity Supplied) / (% Change in Price)		
Curve	**PEoS**	**Description**
QS1	0.16	Very inelastic

QS2	0.28	Very inelastic
QS3	0.74	Higher elasticity, nearly unit elastic [good level of price elasticity for a labour supply curve]

Table 8: Price elasticity of supply - projected figures from Figure 9

If we accept the basic premise, from our discussion of labour market theory, that the higher elasticity of QS3 results in a more optimal economic position in the ICT labour market (and a position that stimulates economic growth more than the current position of the ICT labour market), we can now elaborate on some education-based variables that can be used to engineer this desired increase in elasticity.

Before we turn our attention to supply side variables that can influence supply and supply elasticity, we acknowledge, from literature, one critique of increasing the elasticity of supply within labour markets through education focussed projects. Toner (2011) notes that "employers are unwilling to invest in [education and training initiatives] because workers who receive this training can leave to work for another firm before the employer has recouped the cost of training in terms of higher productivity and output" (emphasis added). Education is good for the industry, but not always profitable for the companies investing in this increase in labour supply elasticity due to the difficulty of retaining newly educated skilled labour, especially in a scarce skills environment. If, because of the risks associated with investing in education, companies then decide not to invest in increasing the elasticity of labour supply through education, the resulting capital investment and further industry growth we discussed earlier will also not occur. This, in turn, will reinforce any current skills shortages within the industry, leaving companies with few options besides outsourcing their ICT demands. Labour markets have traditionally responded to the abovementioned critique in two ways: (i) increasing the elasticity of supply becomes the responsibility of academic institutions who do not share in industry's profit motives, and (ii) companies approach training initiatives through apprenticeship programs. An analysis of industry's approach to increasing the skill levels of new and existing staff members is beyond the scope of this article, but we note from a recent large scale survey in South Africa (ITWeb, 2011) that (a) companies prefer professional training above all other methods of staff retention, but (b) internship training programs are the least used form of training within these companies. Graduate and post-graduate employees [the supply of which is seen as the

responsibility of academic institutions] are still the most popular choices when recruiting more labour, with employment agencies and internet advertisements being the two preferred tools for matching demanded skills with existing supply. From this discussion we note that academic institutions and private sector companies carry a joint responsibility in moving the ICT labour market to a more efficient state. This relates back to our introductory remark about the ICT private sector not contributing enough towards the education of the personnel they require to function and stimulate further economic growth.

We continue now, in the next section, with a discussion of some variables influencing the career choices of prospective students (and hence the elasticity of supply). The reasoning behind this is as follows: If more students choose to study ICT, this will change the elasticity in the market, make the ICT industry a more attractive career option, and iteratively encourage more students to choose to study ICT.

6) Variables influencing ICT graduate supply – towards a model

In this section we introduce variables that can influence supply level and elasticity in the ICT labour market. Some of these variables have been mentioned in the literature review section of this article, and some of them resonate with previous research of the authors (Breytenbach *et al*., 2012). This section also includes a description of the large scale survey that was undertaken to measure the importance of these variables, and the model the authors constructed to measure the validity of these variables.

6.1 Students' perception and knowledge of the ICT industry as potential workplace, and the role of the media and social recognition

Students' career choices are partially dependent on their understanding of their prospective work environments. Their understanding can be influenced by perceptions that are created by the media as well as the social recognition given to certain work environments. We measured this variable with questions that test the following indicators:

- Student indicates ICT as a possible career preference
- Student shows a basic understanding [correct perception] of ICT as a career
- Student has considered a career in ICT while at school

While measuring this variable we have to acknowledge that secondary school students will have no in depth knowledge about industry shortages or labour market elasticity. This is where the media and social perceptions come into play. A secondary school student may, as an example, interpret the increased elasticity and supply stability within the ICT industry, through pure media influence and popular social views of ICT, as the industry offering a good basic salary with good growth potential, and [if asked] may present a gut feeling that the industry is still expanding/growing. In the sections to follow we investigate prospective students' understanding of ICT at the start of their tertiary studies and ask students to tell us what their dream jobs are – our findings gives an interesting indication as to the current popularity of ICT as portrayed by youth-focussed media.

6.2 The role of primary motivators in tertiary study choice

For students to choose ICT as study direction [or career] and become part of the South African ICT labour supply, they need the correct information about the industry, portrayed to them by someone that they trust – someone that can influence their career choice. If primary motivators – teachers, parents, and role models – are given the correct information (marketed correctly) about the ICT industry as a workplace, they can make a substantial difference in the career choices of students, and hence in ICT supply elasticity. We asked students who/what their primary motivator/motivation was when choosing what to study, and after basic analysis, confirmed the following indicators for this variable:

- Student had the primary motivation of parents or teachers
- Student indicates personal interest as primary motivation
- Student indicates life experience as primary motivator

The interaction between this variable and the previous one (Student's perception and knowledge of the industry) is also measured statistically in the sections to follow.

6.3 Socio-economic disadvantages and access to ICT resources

From previous work (Breytenbach *et al*., 2012), and in the light of the 2012 ICT charter[18], the socio-economic conditions of secondary schools and the level of ICT access students enjoy before having to choose ICT as a career was considered as a potentially important variable in the South African ICT labour market supply. The following indicators were investigated towards this end:

[18] South African Government Gazette, June 2012, No.35423.

- Student had access to computers and internet at home prior to career choice
- Student had frequent access to computers and internet during secondary school
- Student studied at an economically disadvantaged secondary school

6.4 ICT as a secondary school subject

From literature [Walstrom *et al*., 2008] we note that interest in subjects at secondary school level often inspire career choices. In order to measure the effect of this variable on ICT labour market supply, we asked students that participated in our survey to indicate the following:

- Student had Computer Application Technology (CAT) and/or Information Technology (IT) as subject at secondary school

The interaction between this variable and having parents and teachers as primary motivation for career choice is also measured in sections to follow.

6.5 Salary expectation

From our earlier discussion of how labour markets function in a skills-shortage scenario, it is clear that the salary expectation of new labourers is an important variable. We did not test the salary expectation of survey participants – not even the ones now studying ICT related degrees. The rationale behind this was that survey participants, being first year students at university, would not know what a reasonable salary expectation would be. We discuss this situation again in our conclusion, as this "not knowing" is indicative of a crucial miscommunication of information in the process of increasing ICT labour supply. Prospective students must know about ICT careers and how much ICT professionals earn before they make a career choice.

Career preferences ("dream jobs") were measured as part of the survey, and it is clear that traditionally high-earning jobs remain solidly at the top of the rankings, with very stable careers and industries following them.

6.6 Setting up the survey

All first year students at a representative South African university were asked to complete an online survey shortly after starting with their tertiary studies. The survey was made available (online) to about 7000 students of which 4475 completed the survey. The survey consisted out of 12 questions covering minimal demographic information and the variables discussed above.

6.7 The model

In order to measure the influence of each of the mentioned variables on the desired result – a student choosing to study ICT at tertiary level and eventually joining the ICT labour force – a statistical model was needed. We constructed a basic multivariate model as shown below, and performed regression analysis on the data of the 4475 surveyed students using this model.

Y	student choose to study ICT (and potentially become part of ICT labour supply)
X1	student had the primary motivation of parents or teachers when choosing career
X2	student had CAT or IT as subject at secondary school
X3	student indicated ICT as a possible career preference/"dream job"
X4	student showed a basic understanding of ICT as a career
X5	has considered a career in ICT while at school
X6	had access to computers and internet at home
X7	had access to computers and internet at secondary school
X8	previously disadvantaged school
X9	personal interest as primary motivator
X10	life experience as primary motivator

Table 9: Variables used in supply prediction model

In the sections to follow we show the results of the regression analysis of the survey data using the model, and discuss our resultant findings. We also discuss how the survey results can be translated back to potential increases in ICT labour supply.

7) Survey results – validation of the model

This section presents the results from a large scale survey (4475 students) used to validate the labour supply variables discussed in the previous section.

Table 10 shows what survey students chose to study. We thus had a control group of 371 students (8.3% of sample population) that chose to study ICT related degrees (IS, Informatics, IT, or Computer Science).

Table 10: Breakdown of study choices of survey participants

BCom (excluding IS related courses)	1094
BSc (excluding Computer Science)	833
BA (Languages, Art, Culture, Politics)	661
BEd (Education)	487
LLB (Law)	343
MBChB / BChD / Therapy	325
IS, Informatics, IT	316
BTh (Theology)	59
Computer Science	55
Radiology / Pharmacology	33
Other fields (less than 50 survey entries)	269
TOTAL	4475

Table 11: Career preferences ("dream jobs") of survey participants

CA (Accountant)	653
Doctor / Surgeon	605
Teacher	472
Lawyer / Attorney / Advocate	464

IT / IS / Programming	301
Therapy (Speech, Physio, Occupational)	207
Financial management	174
Actuary	108
Musician	105
Economist	88
Business Analyst	11
Other choices (less than 50 survey entries)	1287

When we compare the results in Table 10 with those from Table 11 – the career preferences of students, an interesting picture starts to emerge. One would think that the 301 students that indicated ICT as a dream job would all be part of the 371 students currently studying ICT. This is not true, however. Only 147 students indicated both studying ICT and it being their dream job, with the majority of students that indicated ICT as a dream career were studying something else (151 students). This poses a question as to how strong motivations were when choosing a study field. The primary motivators for study choices are presented in Table 12.

Table 12: Primary motivators for study choice

Personal interest	1845
Parent(s)	1083
Life experience	598
Family members	288
Teacher	257
Role model	164
Friend	98

Aptitude	93
Unanswered	49
TOTAL	4475
Personal interest + Parent or Teacher	367

Other results include the following:

- 90% of the students indicated having access to a computer at home, and 80.5% indicated having internet access at home
- 80.6% of the students indicated having regular access to a computer at secondary school, and 69.8% indicated having regular access to internet while at secondary school
- 19.4% of the students indicated having CAT as a secondary school subject, and 12% indicated having IT at school.
- 83% of the students indicated that they understand that "computer knowledge" will be essential in their careers (after completing tertiary study)
- 5% of the students indicated having strongly considered ICT as a career option, with 31% considering it weakly (only "once or twice")
- 13% of the students indicated studying at a secondary school that is classified as disadvantaged
- 20% of students indicated at least a basic understanding of what a career in ICT would entail

After a basic analysis of the survey data, regression modelling was performed on the data to see how significant the identified variables were in the students' choice to study (or not study) ICT. These findings are discussed in the next section.

8) Findings and discussion – a return to labour markets

In this section we discuss our findings related to each of the variables measured in the previous sections. We link each variable directly to our human capital approach to the ICT labour market by clearly indicating how each of these variables can increase the supply and/or the elasticity of supply of graduates in the ICT labour market.

8.1 Students' perception and knowledge of the ICT industry as potential workplace

First, no significant relationship could be found between students that indicated ICT as a career preference and students that chose to study towards a career in ICT. Less than half the students that chose to study towards a career in ICT listed an ICT related career as their "dream job". More than half of the students that indicated ICT as a dream career chose not to study ICT. This was a surprising find, and one that suggests that either (i) current popular perceptions of ICT as a career is not negative but is also not strong enough to motivate a decisive career choice towards ICT, or (ii) even though ICT is perceived as a viable career choice, the social recognition linked to these careers are lower than that of other equally obtainable career options.

Second, a highly significant relation ($p < 0.001$) was found to exist between students that showed a solid understanding of ICT as a career and students that chose to study towards a career in ICT. Stated differently, almost all students that chose to study ICT had at least a basic understanding of what a career in ICT would entail. This finding highlights the importance of creating a thorough, realistic understanding of ICT as career option under secondary school students. According to our survey more students understanding ICT as a career will translate directly into more students studying ICT, and hence higher levels of ICT labour supply.

Third, a moderately significant relation ($p < 0.05$) was found between students that considered ICT as one of various career options while still in secondary school and students that chose to study ICT. This finding suggests, again, that perceptions surrounding ICT as a career choice compares well with perceptions about other career options and that, if given the correct information about ICT as a career, a student may choose to study ICT as readily as any other field of study. In future research it would be valuable to measure salary expectation as part of this variable.

From this section we gather that supplying prospective ICT students with correct, realistic information about ICT as a career remains a known key factor in increasing ICT labour supply. The role of the media in supplying this information to students in an unbiased way requires further research. The role of current popular perceptions about ICT as a career also requires further research.

8.2 The role of primary motivators in tertiary study choice

First, a moderately significant ($p < 0.05$) relationship was found between students who indicated that a parent(s) or a teacher(s) had the biggest influence on their career choice and students who now study towards a career in ICT. This was an expected find, with parents and teachers being two

groups that can have a sustained, long term influence on the perceptions of prospective ICT students. This finding underlines the importance of supplying both parent and teacher groups with correct, realistic information about ICT as a career choice. From this finding it can be assumed that if more parents and teachers promote ICT as a competitive career option, more students will choose to study ICT. This will increase the supply of ICT labour and the availability of correct, realistic information about ICT careers and the expected salaries linked to these careers will stimulate an increase in the elasticity of ICT labour supply.

Second, "personal interest in ICT" did not turn out to be a significant indicator of ICT as a career choice, but "life experience" did ($p < 0.05$). This interesting finding may indicate that (i) the perceived importance of ICT/technology in the life experiences of prospective students convinces them that ICT will be a secure, risk averse career choice, or that (ii) personal interest in ICT/technology and its importance in the modern working environment is not a strong enough motivation towards a career in ICT.

From this section we gain that it is important to inform parents and teachers – the groups that have long term influences on the career choices of students - about ICT as a career option, and that the importance of technology in the life experiences of students may also guide them towards considering a technology related career.

8.3 Socio-economic disadvantages and access to ICT resources

We asked students whether they had access to computers and/or the internet at home and/or secondary school, and classified the schools they attended as being economically disadvantaged or not, based on the income profile of the suburbs surrounding the schools.

No significant relationship could be found between students that had access to computers at school/home and students now studying ICT. Furthermore, no significant relationship could be found between students that had access to the internet at home/school and students now studying ICT.

Another interesting finding was a highly significant relationship ($p < 0.001$) between students now studying ICT and students coming from economically disadvantaged schools. Marketing ICT as a viable [rewarding] career choice at economically disadvantaged schools would seem to promise a greater increase in ICT graduate supply than investments into infrastructure such as computers and internet at schools.

8.4 ICT as a secondary school subject

South African secondary school students have the option to choose either Computer Application Technology (CAT) or Information Technology (IT) as secondary school subject. This choice must be made during the second of five years of secondary schooling.

A highly significant relationship ($p < 0.01$) was found between students that had CAT or IT as a secondary school subject and students now studying ICT. This was an expected result, as students with CAT or IT backgrounds will have access to more up-to-date, realistic ICT career information and would have had access to at least one teacher (motivator) with basic knowledge about ICT as a career choice.

Any plan for increasing the supply, and the elasticity of supply, of ICT graduates will have to include guidelines for how to increase the number of secondary school learners taking CAT or IT as school subjects.

9) Conclusion and further research

In this section we summarize our findings in three sections: (1) observations from the labour market discussion in the first part of this article, (2) observations from the supply side analysis that constituted the second part of this article, and (3) a short section discussing the match between ICT labour supply and demand and our thoughts towards a sustainable solution.

It is the authors' opinion that a positive change to the South African ICT labour supply, and an eventual solution to the so called "ICT skills shortage", will be accomplished through *education-driven projects* at (i) secondary school level, (ii) diploma reskilling level, and (iii) at graduate level (skills-matching, reskilling, transition programs, and apprenticeships). Each of these levels thus receives frequent mention in the sections below.

9.1 From labour market analysis (approaching the skills shortage)

The graduate level ICT skills shortage being experienced in South Africa is real, and from available data [and our labour market approach to this data] we estimate a graduate level shortage in supply of about two thousand graduates per year in the fields of software development, business analysis, and mobile application development. This shortage, having been present in industry for some years, has left a total skills deficit of more than five thousand graduates (when we look at available data

conservatively)[19]. Industry demand (the number and type of vacancies available in the market) is dynamic, however, and from experience we suggest that most vacancies not filled for more than two years become obsolete; this suggests a "backlog" of about four thousand vacancies at most. Increasing ICT graduate supply with two thousand graduates per year seems to be an attainable goal, given the recent growth in final year students reported by selected large universities in South Africa[20]. National e-Skills Plan of Action (NeSPA) initiatives are also starting to have a sustainable impact on the number of ICT graduates, and the impact of other e-Skills Institute (eSI) initiatives must still be measured. Cooperation between tertiary institutions are also growing through joint e-Skills initiatives.

From a labour market viewpoint it is important to create a positive, realistic, well-informed view of the ICT industry at both secondary school level and diploma level. Prospective graduates must become more aware of salary expectations, industry growth, and exciting trends in this labour market if they are to choose ICT as a study major and, eventually, a career. Information Systems departments should consider this when marketing towards secondary schools and colleges.

It is clear from the MICT SETA data that many potential ICT graduates do not study further than diploma level. This complex situation requires urgent further research as it suggests a divide between higher education colleges and universities in South Africa. From a human capital perspective we suggest reskilling diploma level students (leaving college) through short graduate level courses (at local universities) that are coupled with industry apprenticeships/internships, making sure these students are not left without work when one or two more years of study could potentially match their skills to industry's scarce skills needs. The creation of such short courses, and a communication channel between colleges and universities should be one of the main focus points of governmental e-Skills initiatives.

The shortage in ICT labour is only one of the concerns discussed in this paper, and as we explicitly state earlier in the paper it is only half the problem. A second [equally important] concern is increasing the price elasticity of the existing supply in order to reduce the crippling effects of the current production possibility frontier on IS industry sectors. As discussed, an increase in the elasticity of supply will result in the investment and productivity increase needed to get the labour

[19] Similar views are expressed in the ITWeb survey summary (ITWeb, 2011).

[20] University of Pretoria and University of the Western Cape data are available on request.

market moving towards [accelerating towards] (1) a continually growing demand for ICT graduates as the industry expands, and (2) a competitive state where supply and demand meets each other closer to current salary expectations.

Supply elasticity is increased through education driven initiatives. Stated differently, education driven initiatives are used to increase variables that will, in turn, increase supply elasticity. This is worth reiterating: the aim of supply-increasing education projects should not be to decrease the measurable skills shortage (difference between supply and demand at the current average salary level) to zero, as a small yearly shortage indicates a healthy year-on-year growth in demand – an indicator of industry growth. The aim of supply-increasing projects should rather be to increase the elasticity of supply in order to stimulate the maximum amount of growth through capital investment while *almost* meeting the industry demand for graduates at a reasonably competitive base salary level. Secondary focus areas of such education driven projects should include making local supply cheaper than foreign supply, increasing the supply chain's capacity to move with [fast moving] demand trends, maximizing the economic welfare generated for both supply and demand stakeholders by eliminating harsh inefficiencies within the ICT labour market, and not allowing the undersupply of graduates to block the growth of the ICT industry.

In this paper we constructed a model to test the importance of several supply elasticity variables, and conclude our findings from this exercise in the next subsection.

9.2 From a supply-side analysis using our career-choice model

The measurements gained from the large scale career-choice survey, as discussed in this paper, identifies four important variables for increasing ICT graduate supply elasticity:

- The number of school learners taking CAT or IT as secondary school subject
- The number of school learners showing a good basic understanding of ICT as a career
- School learners from economically disadvantaged schools are choosing ICT as a career
- Parents and teachers still perform a critical function during the career choice process, and should be given access to up-to-date information regarding ICT career choices

Increasing these variables will, over time, result in a larger pool of ICT graduates, but it will immediately start pushing the ICT labour market towards a more competitive state. It is this "push" that is much needed in the supply chain of ICT labour in South Africa, as it stands in 2012.

At secondary school level the emphasis should be on getting more students into CAT and IT classes (influence subject choices through active marketing), and supplying students with ICT career information. At diploma and graduate level the focus should be on giving students information about how they can reskill themselves (courses are available) in order to match industry needs. Industry has an important part to play at diploma and graduate level, facilitating more internship programs and informing tertiary academic programs with their needs.

The variables mentioned above all indicate a need for a focussed marketing approach by Information Systems departments countrywide to engage students at secondary school level in the right way, with the correct content. Departments should also be aware of how exciting and engaging they portray themselves towards media representatives and schools when busy with marketing activities.

9.3 Supply and demand match

Education and training for newer technologies, such as software development for mobile devices, should be introduced at all three levels in the ICT supply chain – secondary schools, colleges, and universities – in order to prevent future skills shortages and skills mismatches.

The institutions producing the most graduates are placed near the geographic areas requiring the most skills, so students having to relocate [the geographic flexibility of labour supply] were not seen as a major barrier between supply and demand.

Many universities and colleges are aware of the published lists of needed/scarce skills as they are in communication with the MICT SETA, and some institutions are shifting their focus towards hardware skills, software development, and business analysis. It is important that colleges, the primary suppliers of diploma level tertiary education, will motivate their students to continue studying towards graduate level to meet the industry need for graduates. This suggestion guides our thoughts towards the following realization.

9.4 Towards a solution – transition programs

Two types of transition programs – education and training projects focussed on reskilling/realigning learners - are needed in the supply chain: (1) programs that motivate secondary school learners towards a career in ICT, and (2) programs that match the skills of both diploma level and graduate level students with industry needs. Currently (in 2012), there are South African universities working hard towards creating these short, dynamic, industry focussed reskilling courses. The authors of this paper are actively involved in the creation, marketing, and delivery of these transition courses and

suggest this as an area for further research. Current results are still unverified, but indicate that ICT transition programs at secondary school level and graduate level are succeeding as tools for increasing the supply of ICT graduates. Diploma level programs still require much more attention.

We are moving away from a view of the ICT skills shortage where the solution involves mostly capital investment in ICT infrastructure [a shift away from "*dumping hardware and cables*" in Africa], towards a more complex view of the ICT skills shortage where education and training (in the form of transition courses) take primary focus.

Our response to the problem statement of this article - creating a sufficient, sustained supply of tertiary level ICT skills [graduates] to stimulate growth in the developing South African economy – is as follows: human capital is increased through education and training [education-driven initiatives], which in turn stimulates capital investment, a growing demand for more graduate level ICT skills, a more price elastic supply of ICT skills, and accelerated economic growth within the ICT sector. The current ICT skills shortage in South Africa is a symptom of this process in action, and guides us towards the development of transition and reskilling programs.

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5.3 End notes – Part 2

One of the key findings of the article presented in this chapter is the role of longer term relationships as motivators of study and/or career choices. The relationship aspect of this finding is important.

As the study moves towards an answer to the research question, both Part 1 and Part 2 place emphasis on the importance of relationships in the ICT4D landscape. Education-based projects can develop graduates, but [it would seem] only if these projects function within an ecosystem of stakeholders (educators, industry partners, schools and teachers, parents, government) that supports these projects and their goals. Furthermore, students identify the longer term relationships that they have with parents, teachers and mentors as the most important relationships [for them] within this ecosystem that is tasked to guide them towards successful employment. This recognition of long-term relationships speaks volumes against classic, short-term approaches to IS education projects.

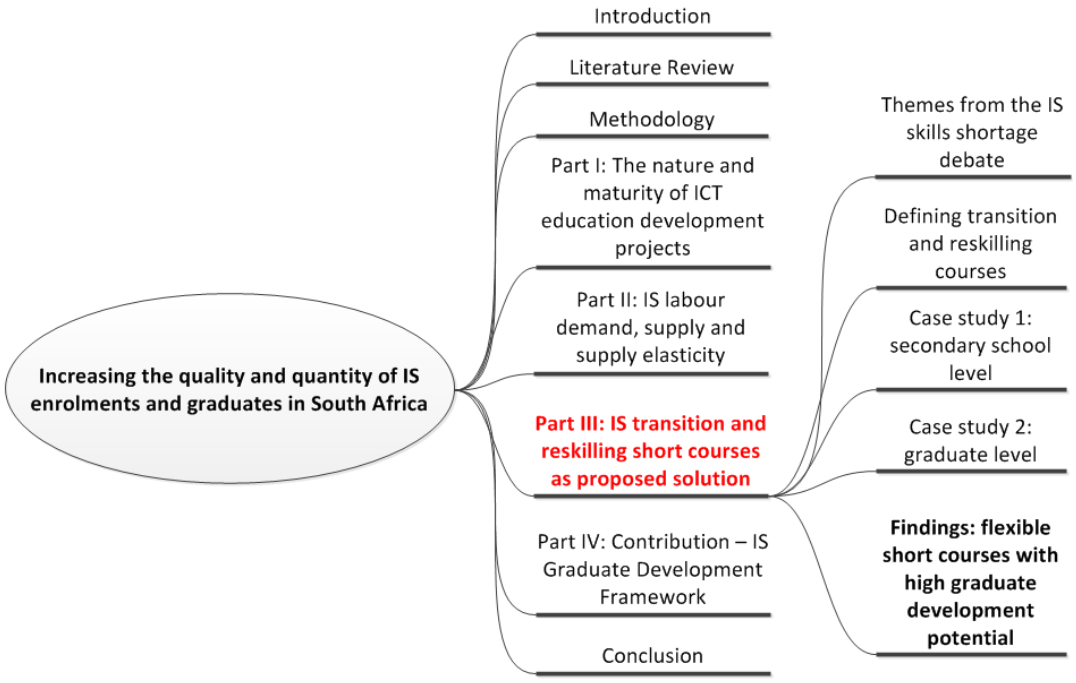
As an explanation, the example of the Khanya project [or, similarly, the Gauteng Online[21] project] that was mentioned in the introductory notes to this chapter can be expanded on. This project was a long-term commitment by government. Infrastructure was successfully put in place and government built long-term relationships with schools and industry partners – on paper this was a good project. In hindsight, the lack of teacher and parent training in this project stripped it of its development potential. Teacher education failed, resulting in student perceptions and skills levels not changing, long-term relationships failing, and IT and CAT not being promoted as secondary school subjects with high industry/earning potential.

The next chapter presents a blueprint for education-based projects that have a chance of succeeding where so many previous efforts have failed. The findings from Part 1 and Part 2 are combined in the design of transition and reskilling courses that fill scarce skills gaps in the South African IS labour supply chain.

As a final end-note to this chapter, it is noted that the model created in this chapter from variables that could be used to predict [and influence] the study and/or career choices of students deserves further application. This model, together with the recent work by Alexander *et al*. (2011), provides valuable insights into how IS departments should be marketed.

[21] Gauteng Department of Education initiative:
http://www.gautengonline.gov.za/scienceandtechnology/Pages/SchoolEducation.aspx

CHAPTER 6: PART 3 – DIRECTING THE SOUTH AFRICAN ICT LABOUR FORCE TOWARDS GROWTH SECTORS



6.1 Introductory notes

"In a global economy where the most valuable skill you can sell is your knowledge, a good education is no longer just a pathway to opportunity – it is a pre-requisite" - Barack Obama – Our kids, our future (2008)

From the findings of Part 1 and Part 2, the scope of the challenge of answering the research question of this study was becoming clear – designing and implementing education-based projects within the e-skills landscape that would sufficiently increase the quality and quantity of IS enrolments and graduates to address the IS skills shortages in South Africa.

Moving from Part 2 to Part 3 of this study was conceptually easier than the shift between Part 1 and Part 2. The researcher now understood both (1) why ICT4D projects often fail [Part 1], and (2) the set of tools that could be used to increase graduate numbers [Part 2]. Part 3 revolves around putting these two groups of facts together into an education approach that will (1) not step into the same mistakes as other ICT4D projects, while (2) influencing education-based variables that will result in an optimal stimulus of IS graduate supply. Saying that this was conceptually an easier task does not mean that the implementation of such a design was easy.

The design of the transition and reskilling courses mentioned in this chapter was influenced by the work of Granger *et al*. (2007) on the challenges surrounding IS enrolments, and Goode *et al*. (2007) on flexible education approaches within IS. Granger *et al*. (2007) shares her concerns regarding IS enrolments as follows:

> *Shifting the focus [of IS courses] to the impact of IS in the organization, treating technology as a tool, and downplaying programming may attract more students who want to interact with people, not computers. Most of the strategies suggested here are designed to address the problem in the short run. In the long run, the current enrolment crisis provides the opportunity to rethink our discipline and what shape it might take in the future.*

The researcher does not agree with "downplaying programming" – the current South African shortage of developers might be a result of such actions – but agrees on a shift in focus towards industry readiness.

Another recent study that played a role in the design direction followed in Part 3 was a study that outlined IS research trends (Gomez, Baron, & Fiore-Silfvast, 2012). Gomez *et al*. (2012) guided the researcher towards combining IS education and mobile technology in a research design, in accordance with IS research trends – see Figure 10.

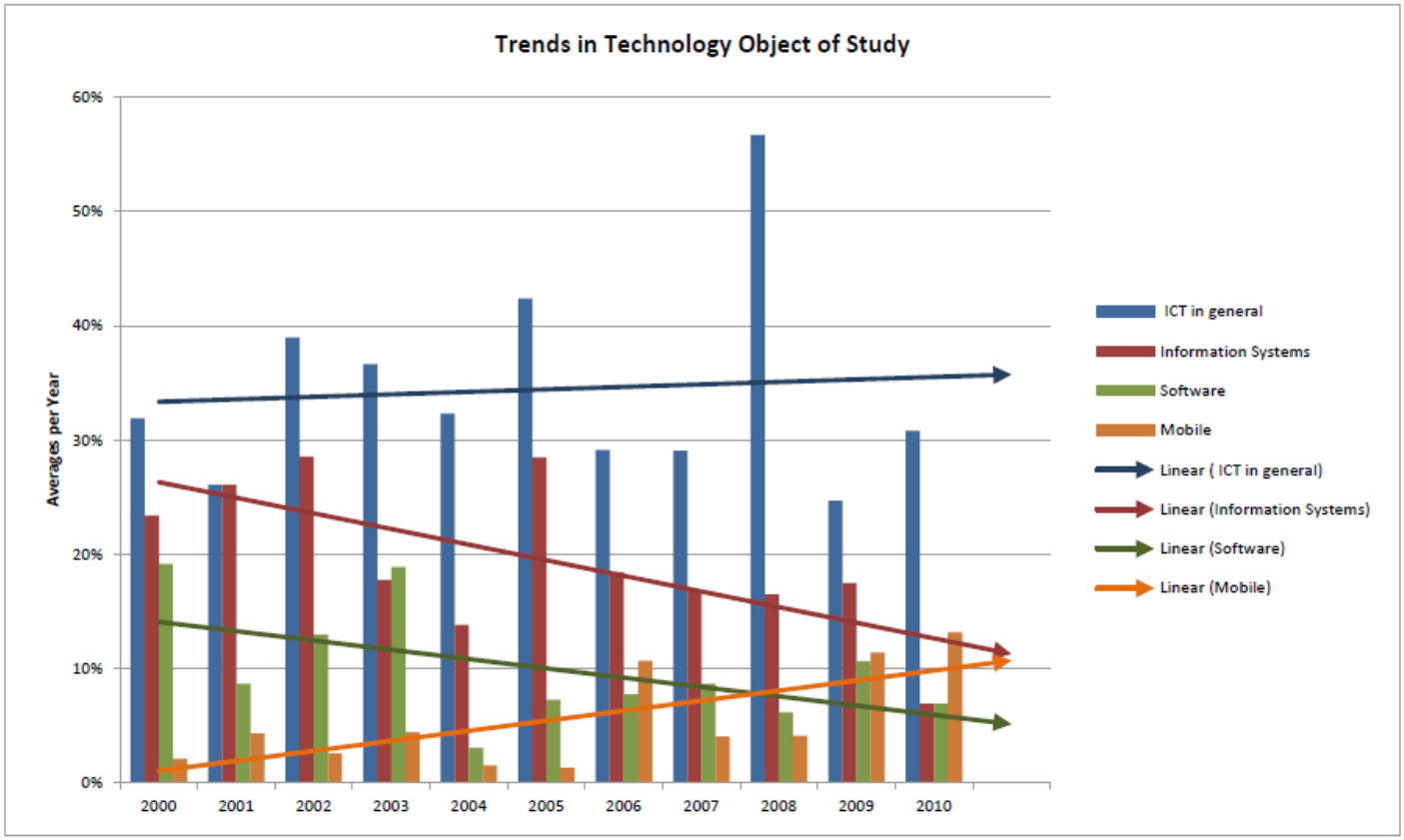


Figure 10: Trends in IS research - technology object of study, from Gomez *et al*. (2012)

In this chapter the findings of the previous chapters are combined with the urgent need for mobile application development skills and mobile-related IS research in South Africa into two short courses [long enough to build relationships] – a transition course and a reskilling course. These courses were implemented, and their successes and failures are reported on as findings.

6.2 Article

Reference: Breytenbach, J., & De Villiers, C. (2013a) Directing the South African ICT labour force towards growth sectors: a case for non-institutional mobile application development transition and reskilling courses. Submitted for review, May 2013.

Directing the South African ICT labour force towards growth sectors: a case for non-institutional mobile application development transition and reskilling courses

Abstract

South African ICT graduate suppliers are under pressure as a result of (i) an existing and well-documented ICT skills shortage in South Africa, and (ii) the rising demand for aptly skilled labour from within the business analysis, software development and mobile application development sectors.

Creating a sufficient, sustained supply of correctly skilled [industry-ready] ICT graduates to meet this growing demand for entrepreneurial [innovative] ICT labour within the core ICT industry [and hence to stimulate growth in the developing South African economy through growth in capacity and entrepreneurial potential] is the underlying goal of this study. To achieve this goal, this article describes ways of stimulating the needed growth in the quality and quantity of ICT graduates who are suitably skilled to take part in core ICT industries in South Africa. This growth is achieved through short courses focussed on innovation and entrepreneurship within the mobile industry and other key scarce skills sectors.

This article presents two case studies describing how mobile application development short courses, as examples of successful ICT education projects in South Africa that have an impact on core ICT , can be used to (i) stimulate growth in the overall industry-ready ICT graduate supply in South Africa, and (ii) grow the entrepreneurial potential within the ICT labour supply.

Throughout this article, suggestions are made regarding the non-institutional nature and maturity of the proposed short courses [classified later as either transition courses or reskilling courses] and the importance of flexibility and industry focus when implementing such courses at tertiary education institutions and in other non-institutional contexts in South Africa.

Keywords: Mobile Application Development, Information and Communication Technology, Labour market, Innovation, ICT Skills

1. Introduction and problem statement

The documented ICT skills shortage in South Africa (Lotriet, Matthee, & Alexander, 2010) is an indication that the local ICT industry, including the core ICT industry, is expanding (Breytenbach & De Villiers, 2012). ICT skills supply can catch up to an accelerating demand through education-stimulated growth (Breytenbach & De Villiers, 2012). This growth in ICT labour supply logically will only result in industry growth if educators can match their curricula with the skills needed for core ICT industry growth by continually re-aiming their courses towards the moving ICT skills demand target. The skills needs [labour demand] for the ICT industry change in nature as technologies and their creative application domains develop, and recent ICT labour market research has done well to identify current scarce skills trends (ITWeb, 2011; MICT SETA, 2011), while acknowledging the uncertain and changing nature of the demand side of the South African labour market. Scarce ICT skills currently include software development skills combined with SQL knowledge, business analysis skills, and new skills such as mobile application development skills. The debate on the ICT graduate shortage did not end with the recognition of the size and nature of the skills shortage, even though this was an important [non-trivial and well-contested] first step. Further research has been done to identify skills shortages and gaps in the ICT graduate "supply chain", and solutions have been suggested (Breytenbach & De Villiers, 2012; Calitz, Greyling, & Cullen, 2010). The South African government has invested substantial resources in infrastructure and institution – particularly in the form of the e-Skills Institute initiative – to address the growing ICT labour supply concerns. This expenditure is validated, as research shows the core ICT and related creative industries to be some of the faster growing segments in economies that are under strain as a result of global economic turmoil (Bridgstock, 2011). In 2012, many of the South African government's initiatives, including the government-funded e-Skills Institute project, reached a growth barrier before reaching a point of sustainability, as resources became less [due to changing government priorities] before academic departments and newly created e-Skills Hubs had the needed momentum (in actual e-Skills Hub education delivery) to stimulate real growth within the ICT graduate supply chain.

This paper is structured as follows. First we pose the research question and discuss the methodology followed. Then we present a short overview of literature pertaining to skills development courses/projects and their context(s) within the South African ICT labour deficiency. This includes a look at the maturity and the non-institutional nature of such courses. Second, we supply two case

studies that support our argument that mobile application development courses will increase the supply of ICT graduates and accelerate the South African e-skills initiative towards maturity. Third, we discuss our findings from the two case studies, followed by the knowledge contribution of this article and a conclusion.

2. Research question

It is from the position discussed in the introduction, a precarious position in which ICT education, including education focussed on mobile industry domain, had been commissioned by governing authorities in 2010 [whose priorities have since changed] but had not been implemented sustainably by 2012, that we pose the research problem of this article:

> Can short courses in mobile application development serve the dual purpose of:-
>
> (i) accelerating current institutionalised ICT/e-skills projects such as the e-Skills Institute project towards sustainability – thus becoming a flexible yet sustainable education-driven tool for increasing the supply of ICT graduates (and the price elasticity of this supply), while [simultaneously]
>
> (ii) driving non-institutionalised growth in innovation and creative entrepreneurship within the South African ICT labour market?

We found early signs to prove that it can, and present two case studies, both following an interpretive case study research approach, to support this argument. Each case study is presented in such a way as to highlight how each project benefited the ICT labour supply chain, and increased entrepreneurial potential within the domain of mobile application development.

3. Research Methodology

This research study was designed to revolve around the development and implementation of two mobile application development short courses at two local universities in South Africa. The one course was structured as a transition course guiding secondary school learners towards tertiary ICT study, while the other course took form as part of a postgraduate diploma in software development.

The research question of this study required a research design and methodology that focussed on the capture of data measures that would indicate clearly whether or not a secondary school learner or a graduate student would become part of the ICT labour supply as a result of the mentioned short courses. To this end, two questionnaires were designed for each course – a pre-course registration

questionnaire and a post-course feedback questionnaire. These questionnaires were used prior to each course and again on completion of each course to capture the data required to present each course as an interpretive case study. The questionnaires were developed to clearly indicate any changes in study/career choices resulting from participation in the short courses. Summarised views of the data are available in the case study sections of this article, followed by an interpretive discussion of our findings.

4. Literature review – the South African ICT labour market in context

In this section we focus the reader's attention on six themes in the literature that together guide the reader towards an understanding of the two case studies to follow. The six themes we present from the literature are (1) ICT graduate supply can be seen as a labour supply chain with evident gaps and opportunities for improvement, (2) ICT development projects [both education and infrastructure projects] can be classified according to their maturity, and maturity is an indicator of sustainability, (3) the ICT skills shortage in South Africa can be seen as a symptom of a healthy, growing core, but then the education-driven ICT labour supply must be (re)geared to keep up with this demand and accommodate changing industry needs, (4) there is a real danger of missing the opportunity to rectify mistakes in a fast-changing supply chain when proposed solutions become over-institutionalised, (5) mobile application development is a suitably flexible field of study and teaching platform for the education delivery that will have to take place to stimulate the required growth in the ICT labour supply and its entrepreneurial potential, and (6) we differentiate between two types of short courses: transition courses and reskilling courses. Each theme contributes towards our final argument and will now receive brief attention.

4.1 Defining core ICT fields

We define core ICT fields according to the list of skills required in the South African ICT labour market (MICT SETA, 2011). These fields include, but are not limited to, software development, database management, business and systems analysis, web development, and mobile application development.

Sadabash (2012) provides a comprehensive definition of the ICT industry and its sectors, and a detailed, standardised ICT occupation taxonomy that includes the occupations mentioned above. We use this definition, together with the MICT SETA list of scarce skills, to define the core ICT industry. In this article we refer specifically to the IS occupations listed in this taxonomy when using the terms "core ICT" or "core IS" labour. Mobile application development, as an ICT labour

occupation grouping, is not a traditional IS speciality, and is not clearly defined in ICT occupation taxonomies in the literature (Sadabash, 2012). Mobile application development, however, can be seen as a subsection of software development, and we therefore include it in our definition of core ICT labour.

4.2 The ICT graduate supply chain

The supply side of the ICT labour market can be seen as the result of a supply chain starting at secondary school level, progressing through tertiary education [certificate and diploma levels] to graduate level (Calitz *et al*., 2010). Recently it was suggested (Breytenbach & De Villiers, 2012) that there are known mismatches between the skills supplied by this supply chain and the skills needed by the South African ICT industry. We refer to these mismatches synonymously as "skills gaps" or "skills shortages" resulting from the supply chain. These gaps must be addressed simultaneously at all levels of the supply chain for overall supply to increase and for the quality of this supply to improve.

This article's primary concern is finding ways, using mobile technology short courses, of increasing the ICT graduate supply produced by academic institutions in South Africa. Our focus is thus institutional. When we refer to the ICT supply chain, we are referring to the collection of *institutions* generating new ICT graduates in South Africa. One of our concerns, as discussed later in this article, is that education within the ICT labour supply chain has indeed become over-institutionalised, and too inflexible to be able to handle the changing nature of ICT demand.

In this article we agree with the view of ICT graduate supply as resulting from an academic, institutionalised supply chain, and our two case studies target two different parts of this chain – secondary school level and graduate level. We argue for making this supply chain more flexible through non-institutionalised short courses.

4.3 Viewing graduate-increasing projects from a maturity perspective

Breytenbach, De Villiers, and Jordaan (2012) critique the lack of maturity of education-driven and infrastructure-driven ICT development projects in South Africa. Their findings include the observation that education development projects are sustainable after reaching a maturity level categorised by *diffusion*. Diffusion is a term used to describe development projects that have a broader effect than their original intention. An example of such diffusion would be a student who turns knowledge gained through education development into an entrepreneurial [innovative]

business concept and then moves to further business development (*diffused* financial growth as a result of social/knowledge growth). The concept of diffusion is borrowed from welfare economist Sen (1999) and his work on diffused increases in economic freedom.

If the "diffusion" maturity level is not reached by projects that aim to increase ICT graduate supply by the time that the project budget is spent [donor funding runs out], does this lack of maturity mean that the education project will fail? Not always, but it would mean [by definition of diffusion maturity] that the project is not yet sustainable, and that the project (for example the e-Skills Institute project mentioned earlier) has only a marginal chance of success if resources are withdrawn at such an early stage. There is a direct link between diffusion maturity and project sustainability.

As an early critique of the project, we theorise that the South African e-Skills Institute initiative is starting to show signs of struggling to reach [and move beyond] diffusion maturity due to the immature lessening of government resources during 2012 [as a result of a change in government priorities]. As our case study findings suggest, the e-Skills Institute project [and similar ICT labour-increasing projects] can be accelerated towards *diffusion* maturity through high-impact short courses aimed at increasing ICT graduates and/or developing entrepreneurial potential in the ICT labour supply.

ICT development project maturity depends on other variables besides just observing diffused development potential, but these variables fall beyond the scope of our argument. For a comprehensive review, see Breytenbach *et al.* (2012). For the purpose of this article we want to determine whether or not diffused development took place in our two case studies as a measure of the maturity, and hence sustainability, of these two projects.

4.4 The ICT skills shortage as a symptom of normal industry growth

As part of the discourse on stimulating economic growth by increasing the ICT labour supply, the literature contains a rich vein of descriptive research on the existence of a South African ICT skills shortage. This ICT skills shortage can be approached from an economic labour market supply and demand perspective (Breytenbach & De Villiers, 2012; Merkofer & Murphy, 2010). Human capital theory and economic signing theory are often used to inform such ICT labour market studies (Toner, 2011).

Using a human capital labour market approach, Breytenbach and De Villiers (2012) present a positive view of the e-skills shortage as a symptom of growing core ICT. This view is followed, however, by a

disclaimer. Even with indicators showing that ICT labour-consuming industries are growing, the ICT labour market is precariously positioned and currently in a non-competitive state. Graduate supply can now grow [keep up] with growing demand – ways of stimulating such supply growth is discussed later in this article – or the institutions responsible for stimulating the supply chain can miss out on the development potential of the current (non-optimal, non-competitive) market position by focussing on skills and/or the implementations of skills that do not match the current industry and government needs.

In this article, as portrayed by the two case studies, we suggest short transition and reskilling courses to push the ICT labour market in a more competitive direction.

4.5 Missing opportunities for corrective growth due to institutionalisation

With this section of our literature review of the ICT labour market, the authors take the risk of possibly confusing the reader regarding the main argument of this article, in the hope of gaining something valuable: an important conceptual classification of the nature of education-driven ICT development projects, and the kind of projects that should be used to close the "skills gaps" in the ICT graduate supply chain.

In the same way as education/development projects fail due to a lack of maturity (refer to our discussion in an earlier section), such projects also risk failure if they become over-institutionalised. Before we define this institutionalism from the literature, we make a laymen's observation on the case studies we present later: placing too many institutional restrictions [or expectations] on immediate, flexible syllabus changes and/or education approach changes may cause the resulting courses to fail in reaching their development goals. Quick courseware and syllabus changes are needed to strengthen all levels of the ICT labour supply chain in order to increase the quantity of ICT graduates, but also [equally important] to change the type and quality of student graduating in ICT.

In a recent publication that addresses, amongst other topics, the nature of development projects, Sen (2009) writes about institutionalism, *"[transcendental institutionalism] tries to identify social characteristics [a set of institutions] that cannot be transcended in terms of justice [increasing freedom]*", and "*in searching for perfection, transcendental institutionalism concentrates primarily on getting the institutions right*". Applying this to education-driven ICT development, we state that education-driven development projects following a transcendental institutionalism approach [such as the e-Skills Institute initiative] view development as a clear growth path leading developing entities [students and community members] closer to being "perfectly" positioned for employment,

fully developed, fully educated, ready for employment as productive labourers; a state that can be described clearly in terms of the institutions used to reach it. The primary goal of development projects within this approach is putting in place institutions (education centres, frameworks, rules, companies, workgroups, technology standards, IS tools, IS infrastructure, skills hubs, information centres, etc.) that will allow entities to reach a state of being perfectly developed [or in our context, immediately employable in a scarce skills ICT sector]. Many education-focussed development projects buy into the transcendental institutionalism development philosophy because it lends itself so naturally to domains with institutionalised supply chains.

Academic institutions must be wary of their own institutional nature and guard against over-institutionalising short courses [interventions/flexible skill increases] aimed at alleviating the current ICT skills shortage. Academic institutions erroneously over-institutionalise development opportunities by aiming to put in place a comprehensive set of institutions (rules, accreditations, and governing bodies) that will result in a one-size-fits-all cure for the already over-institutionalised ICT labour supply chain and move it towards an imagined transcendental state in which more than enough industry-ready ICT graduates are produced each year. Academic institutions must also guard against expecting industry to take ownership of the less institutionalised forms of training – flexible short courses, application-specific short courses, media-specific short courses, and so on. Taking too long to implement the needed syllabus changes to stay in touch with industry demand [due to heavy institutional restrictions or a lack of ownership] dilutes the development potential of such courses [and makes the entire ICT labour supply curve more price inelastic].

Sen (2009) suggests a way of steering clear from falling into a transcendental institutionalism trap – an approach of comparative realisation. For the sake of simplicity we will call this (arguably better) development philosophy the “comparative” approach, and not realisation-focussed comparison, as Sen (2009) called his theory. ICT development projects following this approach view development as a flexible path without a fixed [near perfect] end-point, and without a perfect technology- or education-driven solution, that is aimed towards when entities are developed. Development within this approach is viewed as an ongoing, *continual evaluation of actual possibilities* for increasing the economic and social freedoms of people; a comparison and ranking of each possible development opportunity. The actions that will maximise [optimise] development are then implemented, using the ICT tools [education tools] and other resources needed to manifest the envisioned development. This is a flexible approach to project management that allows for changes when they are needed, even if this means that all future project goals must be changed accordingly. In an ICT labour market

context, this approach suggests that each group of students must be measured, that realistic development opportunities [skills gaps] must be identified, and that the opportunity that will result in the greatest development [the scarcest skills being developed?] must be focussed on first, using a flexible education approach [transfer the most-needed skills as quickly as possible].

This might come over as a very theoretical distinction between institutionalism and the comparative realisation approach to ICT development projects, but it makes a significant difference to the way we look at proposed solutions to the ICT labour shortage. We understand from Sen (2009) that we can lose out on development potential if the institutional changes [the institutional burden to be carried] required by a proposed solution [education-driven project] are too great. A moving development target [goal] requires a moving solution.

Mobile application development short courses, as discussed later in the article, are one viable solution to one of the major skills deficiencies in the ICT field, but can lose most of their potential [to fill the gaps in the supply chain] if strangled with institutional requirements and aspirations. Next we look at mobile application development as the subject and object of teaching.

4.6 Mobile application development – a suitable starting point

With most of this article focussing on mobile application development as subject matter for short courses, we note that the majority of mobile learning (m-learning) literature focuses on mobile technology as an education delivery platform. We agree that mobile devices can serve a dual purpose, as education medium and subject, in ICT projects aiming towards increasing ICT graduates and the entrepreneurial potential of ICT labour. Therefore we provide a very brief mention of mobile devices as education medium as part of this literature review.

As an example of relevant, existing m-learning literature, Chen and Wei (2012) identify two challenges in mobile learning: (1) the lack of generalisation – one solution only targets one mobile technology such as Android, BlackBerry, or iPhone, and (2) challenges surrounding the creation of optimised e-lesson (m-lesson) content that displays and interacts correctly on different mobile devices. These authors suggest a solution based on e-LML (e-Learning Markup Language), a way of setting out lesson plans in a popular XML format. We suggest looking at similar solutions for mobile

technology as a platform, such as using free mobile blogging solutions to resolve display issues, and new porting tools to translate applications between platforms[22].

With a high level of mobile penetration and a growing level of mobile internet usage In South Africa[23], the potential for mobile devices to be used as a cost-effective (and in many ways innovative) education platform is obvious.

The short course nature of mobile application development is a good match for the kind of tool we need to [quickly and flexibly] stimulate more learners into the ICT labour supply chain. and reskill existing ICT workers towards industry readiness. ITWeb (2011) indicates non-institutionalised training in the form of short courses as the preferred training method for IT companies. We define short courses clearly in the next section.

4.7 Defining transition courses and reskilling courses

We end off our literature review by defining two kinds of short courses, transition courses and reskilling courses, as mentioned in the title and the introduction of this study.

We loosely define a transition course as a short course that helps the learner/student to progress smoothly from one phase of the supply chain to the next phase in the same supply chain, for example from secondary school ICT study to tertiary-level ICT study. Such courses are typically used to even out the technical learning curve related to scarce skills-related fields of study, such as computer science or mobile application development, giving students a greater chance of success. Transition courses are aimed at preparing a student for the learning that will take place in the next phase of his/her education. The first case study presented in this article describes a short course that can be classified as a transition course.

Other short courses fall into a category we call reskilling courses. A reskilling course moves the learner/student from one labour supply chain to another. Stated differently, the learner/student is made ready to take part in an industry other that the one his/her studies aim towards. For example, a short course that teaches an econometrics student how to develop mobile applications is a

[22] See, as an example of such a porting tool, the BlackBerry Apps Generator: http://www.blackberryappgenerator.com/blackberry/

[23] News article: http://www.iol.co.za/business/business-news/cellphones-boost-sa-s-internet-penetration-1.1294151#.UKvfIIdkyAg

reskilling course. The second case study presented in this article describes a short course that can be classified as a reskilling course.

In this article we provide early proof that both transition and reskilling courses in mobile application development provide workable solutions for filling the skills gaps in the ICT labour supply chain, while keeping up with current ICT industry skills needs – solutions that are mature and non-institutional in nature.

This concludes our literature review of the ICT labour market landscape in which we want to stimulate supply-side growth through education. In the next two sections we present two case studies that guide us towards a solution for our research problem. Each case study will be presented as a brief description of the project in question, followed by a project summary in tabular format.

5. Case study 1: Mobile application development as motivation for further ICT study – a transition course

One ICT labour supply chain gap mentioned in the literature is secondary school learners' lack of understanding of ICT as a career while deciding what to study or pursue as a career (Breytenbach & De Villiers, 2012; Calitz, 2011). In South Africa, a secondary school learner must choose his/her preferred secondary school subjects after completing two out of five years of secondary school – reaching this career path choice at the age of 14 or 15, when ICT industry knowledge is usually limited.

The project described in this case study – the Mobile Application Development (MAD) Challenge – was aimed at secondary school learners aged 16 and older – learners who had already made their final subject choices at secondary school level. The goal of the MAD Challenge was so see how school learners who have indicated an interest in ICT by choosing IT or CAT (Computer Application Technology) as a secondary school subject compared with learners who did not choose IT or CAT as a subject when participating in a mobile application development short course with a strong entrepreneurial focus [conceptualising and writing applications that could potentially make money].

Table 1: Summary – MAD project 2012

Number of learners accepted for course	60
Number of learners who completed the course	30

Entrepreneurial ideas/creative applications generated	16
Percentage of course-finishing learners who indicated an interest in ICT jobs prior to course	18/30 = 60%
Percentage of course-finishing learners who indicated an interest in ICT jobs after the course	25/30 = 83%
Number of non-ICT-studying learners indicating ICT as a career preference after the course	3
Number of learners who changed their career choice to ICT as a direct result of the course	7

Students were measured before and after their participation in the course regarding their interest in ICT as a possible career choice, their primary motivations when making study/career choices, and their basic understanding of the ICT industry. The MAD project was set up with the underlying hypothesis that short courses of this nature could potentially stimulate growth in the group of secondary school learners who choose to become part of the ICT industry by giving learners a feel for the new and exciting entrepreneurial opportunities and the job satisfaction to be found in ICT. A summary of basic measures for the MAD project is presented in Table 1.

All MAD participants indicated an interest in ICT at a young age prior to the course, but not all learners had IT or ICT as secondary school subject. Of the thirty students who finished, seven did not have IT or CAT as a school subject. Of these seven learners, two changed their minds about studying ICT at a tertiary level as a result of the course, and indicated a need for more information regarding available courses, especially ICT courses related to software development. One learner indicated a 50% possibility of changing her mind from studying medicine towards studying ICT, and this student's mobile application reflected a keen dual interest in both medicine and technology – potentially an embedded ICT professional within the medical field? The other four non-IT learners who finished the course indicated no clear choice for or against further ICT study, with all four indicating that they needed more information about occupations within the ICT industry before making further study choices.

This short course in mobile application development was non-institutional in nature. It was structured as a prestigious competition for promising secondary school learners from nine schools, and took the form of a ten-week boot camp, structured as six informal [yet intensive] tutorial

sessions, followed by four weeks of unstructured laboratory work in groups or as individuals. The non-institutional nature of the course allowed participants the freedom to work at their own maximum pace and on their own topics of interest, which, in turn, had a direct effect on the level of creativity and entrepreneurship that manifested as a result of this course.

This short course also showed early signs of reaching diffusion maturity, both within the academic institution that facilitated the course and in the applications developed by the participants. The course has had a positive impact on the marketing approach followed by the academic departments in question [as an example of direct diffusion] and has resulted in several mobile applications that could generate income for course participants after course completion. The observable diffusion was confirmed when the project was approved to run again, on a bigger scale, in 2013 – the project had reached diffusion maturity.

The competition was set up with particular sensitivity towards social maturity variables, as discussed in Breytenbach *et al*. (2012), and variables that could increase the ICT labour supply chain price elasticity, as discussed in Breytenbach and De Villiers (2012).

Seven learners changed their minds regarding their dream jobs and possible career choices towards ICT as a direct result of this short transition course in mobile application development.

6. Case study 2: Reskilling graduates to meet industry needs

Whereas the first case study can be classified as a transition course – preparing students for a higher level of study in the near future – the second case study describes a reskilling short course.

This reskilling course was structured as a postgraduate diploma, with fourteen weeks of structured lectures. The course content, taking participating students through (i) programming fundamentals, (ii) web fundamentals, and finally (iii) mobile application development using Java, was structured into seven two-week sections, each presented as a postgraduate subject. The seven subjects then made up the postgraduate diploma. Table 2 displays basic information regarding this course.

Table 2: Summary – postgraduate diploma project

Number of learners accepted for course	32
Number of learners who completed the course	15
Entrepreneurial ideas/creative applications generated	3

Number of non-ICT-studying learners indicating ICT as a career preference after the course	10
Number of learners entering directly into the ICT labour market	8

This course, although slightly more institutionalised in nature, was still flexible enough to align with changing industry needs. The advantages of this flexibility became clearer as the 14 weeks of lectures progressed, with the focus moving towards mobile development as the need for such skills were expressed by companies offering internships to participating students. The coursework was adjusted mid-stream – a good working example of Sen's comparative realisation approach to development (Sen, 2009). The slightly more institutional nature of this project had an additional side benefit of giving participants an accredited reference when applying for work in the ICT industry – an industry new to all of them.

Eight non-ICT graduates were successfully reskilled through this flexible, minimally institutionalised software and mobile development course, and have already entered the ICT labour supply chain at the graduate level. Three of these students are now working for the companies that offered them internships for the duration of the course, which hints [again] at the importance of preparing students for industry through practical exposure [increasing industry readiness]. There is an epistemological overlap between this project, being industry and internship driven, and the work of Araya and Peters (2010), which discusses the preparation of graduates for employment in the technical and creative industries by focusing on their level of embeddedness in the industry.

Further findings from both case studies are discussed in the next section. These findings relate back to the themes covered in the literature review.

7. Findings and discussion – The dual purpose of mobile application development

Diffusion maturity was reached within a year in the transition course project described in the first case study, and this critical level of maturity may soon be reached by the reskilling course discussed in the second case study. The early indicators of success shown by the second project have motivated the e-Skills Institute coordinators to investigate the facilitation of similar courses within the Institute which, if implemented, would be a measurable diffused increase in freedom resulting from the project in question. Indications are that these reskilling courses would be open to industry workers in need of being reskilled towards industry readiness.

From the summary in Table 2 it would seem that the increases in (i) ICT labour supply and (ii) entrepreneurial potential in the ICT labour supply chain were less for the project in the second case study than for the MAD project discussed in the first case study, but the authors argue against such a conclusion. The diploma short course, focussing on reskilling non-ICT graduates into industry-ready ICT graduates within 14 weeks, had a much harder task at hand than persuading secondary school learners to indicate that they would potentially study ICT. Having eight [previously unemployed] non-ICT students with confirmed permanent employment within core ICT companies after only 14 weeks of reskilling is an exceptional result.

The two case studies discussed above confirm some positive characteristics of mobile application development short courses. Short courses in mobile application development, both transition and reskilling courses, (a) reach the desired "diffusion" level of project maturity relatively quickly, as they are cost effective, reasonably easy to facilitate, and have a measurable impact on the employability of participants (which makes these projects easier to embed in social structures); (b) seem to attract quality students into skills gaps – talented individuals who, through transition or reskilling, can be integrated into the ICT labour supply as high quality graduates; (c) do not only guide students towards employment in the core ICT industry, but also perform the function of motivating students towards becoming ICT professionals embedded in the innovation and creative industries; and (d) work at all levels of the ICT labour supply chain. Our case studies provide evidence of these courses bridging information gaps at secondary school level and reskilling postgraduate students for ICT industry readiness. Finally, mobile application development is a suitable subject for such transition and reskilling courses – it meets industry needs and supports entrepreneurial career paths in core ICT industries.

8. Conclusions and further research

We started this article by questioning whether or not mobile development short courses could (i) accelerate current institutionalised ICT projects such as the e-Skills Institute project towards sustainability, while (ii) driving non-institutionalised growth in innovation and creative entrepreneurship within the South African ICT labour market. The first question can be answered with certainty. With two case studies we have provided sufficient proof that mobile application development short courses reach maturity quickly and can be delivered with minimal institutionalisation. Such short transition or reskilling courses can be used as agents of acceleration, stimulating new or existing education-driven projects towards sustainability and [later] project success – with the assumption that success is defined as filling skills gaps within the ICT labour

supply chain and increasing the employability of course participants. The second question, regarding mobile short courses engineering an increase in the level of entrepreneurship within the ICT labour market, touches on a more complex discourse about the kind of labour [entrepreneurial in nature] that seems to be driving growth within core ICT industries and related fields. Both Flew (2011) and Bridgstock (2011) mention entrepreneurship as an important variable for industry growth and increases in labour employability within the creative industries. This suggestion, that entrepreneurship drives industry growth, especially through multidisciplinary applications, together with the level of innovation that we observed in the two case study projects, guides us towards an answer to our second research question.

Mobile application development as a subject encourages multidisciplinary applications [implementations] – the use of technology in traditionally non-technical fields – and unlocks entrepreneurial ideas at all levels of the supply chain by giving non-technical thinkers and students with creative skillsets an entry point into the mobile [mass/global] market in a cost-effective way. Both case studies were characterised by high levels of feasible new business ideas and innovative applications of mobile technology outside of what would be classified as core ICT industry.

We acknowledge the need for more rigorous research regarding the relationship between the evident entrepreneurial potential of ICT graduates and mobile development skills and ICT industry growth, as well as the relationship between entrepreneurship and growth in the demand for both core and embedded ICT labour.

We conclude this article with three practical suggestions for consideration by stakeholders involved with the e-Skills Institute project and similar education-driven initiatives in South Africa. First, mobile application development should be considered as a tool with which to make up lost ground in the development of ICT labour. We suggest combining mobile application development as subject with current m-learning trends in South Africa[24]; mobile devices create an applicable vehicle [platform] for mobile application development education and other short transition and reskilling courses. We should consider options such as mobile applications that help the user to write his/her own mobile applications on popular platforms with greater ease – triggering further entrepreneurial innovation.

Second, we suggest delivering mobile application development courses with as little as possible institutional restriction. Quality, consistency and accreditation must be ensured, but both case

[24] See, as an example, the work of IT Schools Innovation (http://www.itschools.co.za).

studies indicate the need for flexibility in approach when aiming towards filling fast-moving ICT skills gaps. South Africa is moving away from a "university focused solely on technology" approach, a concern mentioned by Lotriet *et al*. (2010), as this works against the principles of realisation-based comparison by over-institutionalising the ICT labour supply chain.

Finally, we propose the creation of a network of educators who can move easily between academic institutions and industry and fill the ICT skills gaps in core ICT areas in both these areas. The e-Skills Institute initiative has resulted in the creation of a strong network of educators with the common goal of increasing employability and innovation in the ICT labour market. This network can be used to facilitate short transition and reskilling courses in scarce skills areas countrywide.

Can mobile application development short courses be used to redirect the South African ICT labour supply chain towards meeting industry demand for higher levels of core and embedded ICT labourers with higher entrepreneurial attention? We believe it can.

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6.3 End notes

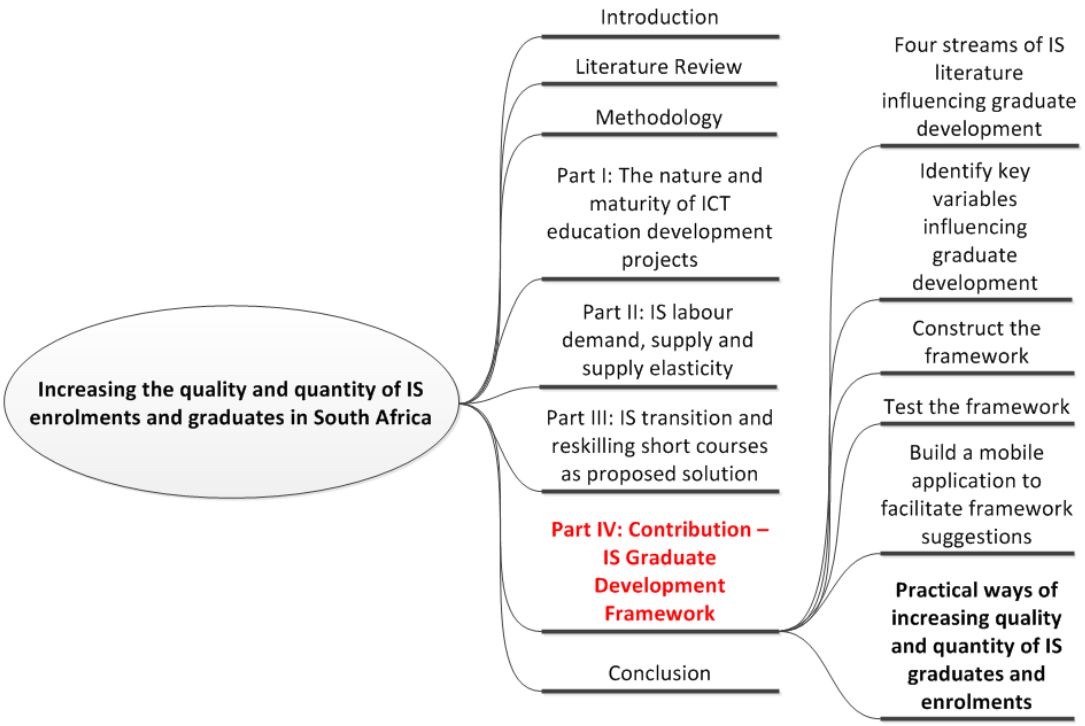
There is a fine line between creating the structure, relationships and policies needed for IS graduate development projects to function within existing education structures [institutions], and losing the required speed and flexibility of implementation needed to address the IS skills shortages in South Africa by over-burdening these projects with institutional requirements and restrictions.

An example of the abovementioned balance between timely implementation and having the required policies in place is in order. In Part 3, and in Part 4 that follows in the next chapter, the involvement of industry is mentioned as a key success factor for IS graduate development projects. Industry involvement is included as an important variable in the contributory framework of this study, the IS Graduate Development Framework (ISGDF). Involving industry will ensure that curricula stay up to date and are targeted directly at industry skills needs, which will speed up the IS graduate development process and, in many ways, will require the education approach followed to be more flexible. Industry involvement, however, also requires legal restrictions [policies/agreements/ understandings] to be in place, especially regarding issues of intellectual property and student labour. Two solutions seem to be poised against each other: (1) maintain a distant relationship between education institutions and industry, where industry plays the role of charitable donor, uninvolved in the task of matching student potential with industry needs [and losing out on industry's valuable contributions], or (2) build a more complex relationship between industry and education institutions, having industry intimately involved in the skills-matching process, which will require legal restrictions/policies to be in place [and makes the process less flexible]. This single relationship between education and industry [there are many others] within the multi-stakeholder skills development landscape (see Figure 22 in section 8.1.2) has several underlying assumptions that could be tested through critical research, and several workable realisations.

Part 1, Part 2 and Part 3 informed the researcher's knowledge of probable solutions for increasing graduate numbers and quality, with the understanding that the relationships surrounding an IS graduate development project are important and complex. This understanding influenced the design of the IS Graduate Development Framework, presented in the next chapter as Part 4 of this thesis. The framework resolves some issues around the mentioned friction between speed of implementation and the need for policies and procedures to be in place for implementation to pick up speed, by stressing the importance of relationships between education institutions, communities and industry. The nature of these relationships, and ways of lessening the friction in these

relationships, are discussed in the Conclusion chapter of this thesis, focusing on conversations that matter.

CHAPTER 7: PART 4 – A SOLUTION (CONTRIBUTION AND FRAMEWORK)



7.1 Introductory notes

"Conformity is the jailer of freedom and the enemy of growth" - John F. Kennedy

In this part of the study we combine the findings from the previous three parts into a coherent framework that measures the graduate development potential of IS projects, courses and institutions.

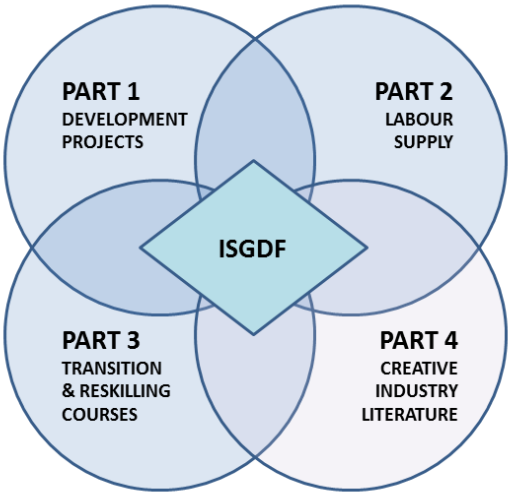


Figure 11: Visual presentation of literature underpinning the IS Graduate Development Framework (ISGDF), presented in Part 4 and Part 4B.

This part of the thesis is much more that a reworked version of previous findings. As suggested in the figure above, prior findings were enriched with applicable creative industry literature. After presenting the ISGDF, the framework was tested by measuring the graduate development potential of one of the case study projects from Part 3 with the framework. The results of this measurement are discussed and translated into practical guidelines for improving IS graduate development projects.

In order to demonstrate how the framework's suggested improvements can be implemented in a way that adheres to the twenty guidelines set out in the framework, the development of a mobile application that facilitates some of the framework's suggestions in an IS course scenario is described. The mobile application is demonstrated and discussed in a section of the end notes to Part 4; see section 7.3.

7.2 Article

Reference: Breytenbach, J., & De Villiers, C. (2013b) Increasing the quality and quantity of tertiary level Information Systems graduates – a graduate development framework. Submitted for review, March 2013. Peer reviewed, April-May 2013, and resubmitted, June 2013.

Increasing the quality and quantity of tertiary-level information systems students – a graduate development framework

Abstract

This article forms part of research-in-progress aimed towards creating a comprehensive graduate development framework that will assist Information Systems (IS) departments in increasing the quality and quantity of their enrolments and graduates.

In this article we present the IS Graduate Development Framework (ISGDF). This framework combines measurable, tested variables from four IS education related fields of study into a single framework for measuring the graduate development potential of IS institutions, courses, and development projects. These four fields of study are (i) Information and Communication Technology for Development (ICT4D), (ii) economic labour market theory that relates to IS labour, (iii) a study of IS education variables and course structures, and (iv) a study of IS labour within the Creative Industries. We present the ISGDF based on literature from these fields of study, and show how this framework can be applied by means of a comprehensive case study example. The case study gives a detailed account of how the framework was used to measure, and improve, an IS graduate development project.

Findings from the case study include several areas for possible improvement of IS curricula to increase the graduate development potential of IS departments. Although the case study was conducted in a South African context, we suggest that the ISGDF, and case study findings report in this article, can be useful for informing IS departments towards increasing graduate quality and quantity in their own contexts.

Keywords: IS education, ICT4D, ICT labour, Human Capital, Mobile Application Development, Graduate Development Framework

1) Introduction

With the South African Information Systems (IS) skills shortage as motivation (Breytenbach & De Villiers, 2012), this article presents the task of increasing the quantity and quality of IS enrolments and graduates in South Africa as a high priority development concern. This article forms part of a longitudinal study of variables that influence IS enrolment and graduate numbers, with frequent mention made to recent related studies (Breytenbach & De Villiers, 2012; Breytenbach & De Villiers, 2013; Breytenbach, De Villiers & Jordaan, 2012).

In order to present a comprehensive framework [plan of action] for increasing the quality and quantity of IS students, this complex research problem had to be divided into manageable sections. This study was logically divided into four themes that presented themselves through research involvement in graduate development projects. These themes, which in turn were interrogated for measurable variables that could influence graduate numbers [or the quality of existing graduate students], are: (i) the importance of social development variables in graduate development (this relates to the ICT4D field of study), (ii) a consistent lack of industry involvement and industry-readiness focus when approaching the IS skills shortage (this relates to economic labour shortage theory, including human capital theory), (iii) the need for shorter and more flexible courses [projects] that could be used to address severe skills gaps in the short term, and (iv) the need for IS curricula to prepare students for the abundant employment opportunities within the Creative Industries. Significant variables from these four themes were combined into a four-part framework that we present in this article.

Although this study focussed on the development of IS graduates, some of the literature referenced in this article discuss the use of Information and Communication Technology (ICT) for development (ICT4D). We acknowledge the difference between IS education development and ICT4D, and state that where ICT related studies were used within our argument, they were used with care and only when these studies allowed for IS skills to be seen as a subset of ICT skills (both might then be influenced by the same projects).

2) Problem statement

We state the research question of this article as follows:

- What are the main variables influencing graduate quality and quantity?
- Can these variables be combined into a framework and used to increase IS graduate supply, thereby presenting a solution to the IS skills shortage in South Africa?

3) Research Methodology

The framework was constructed by combining variables from literature discussed in the next section. The framework was then tested by allowing IS education project facilitators to use it as an assessment tool – one such process is presented as a case study. The testing process resulted in valuable insights regarding successful graduate development projects. This article forms part of a longitudinal study measuring the success of the case study project and similar IS education projects in South Africa. The results presented in this article, being based on a small empirical dataset, are validated by the need within the South African e-Skilling debate for (i) a recent, transparent baseline study against which results from similar graduate development projects can be measured, and (ii) an accompanying graduate development measuring tool (framework).

The rest of this article is structured as follows. First, we present an overview of the literature on the mentioned four fields of study (four themes) that inform the presented framework - the IS Graduate Development Framework (ISGDF). Second, we present the summarized framework as a set of twenty measures, categorized into four sections that relate to the four fields of study covered in the literature review. Third, we present a case study that describes how a mobile application development course was measured by using the ISGDF. This includes a lengthy detailed breakdown of the framework's twenty measures into 43 measurable sub questions, populated with questionnaire answers from project facilitators. This section transparently demonstrates project measurement using the framework. Fourth, we discuss how the case study project was significantly improved by using ISGDF measures as guidelines. These improvements included the development of a mobile application that facilitates some of the key success factors of graduate development. Fifth, we present suggestions for improving the graduate development potential of IS courses, and thereby counteracting the growing IS skills shortage in South Africa (Merkofer & Murphy, 2010), as the knowledge contribution of this article.

4) Literature Review

We found significant variables that influence graduate development projects in four parallel streams of development oriented IS literature, and accordingly present a short overview of these variables in the following four sections of this literature review.

4.1 ICT for Development maturity variables

IS education and infrastructure projects that aim towards graduate development often fail to reach a level of maturity that ensures sustainability before donor funding is withdrawn [or depleted]. Using an alternative definition of development as increases in freedom (Sen, 1999) and an existing IT project maturity model (Leem, Kim, Yu & Paek, 2008), researchers investigate the level of project maturity needed to ensure project sustainability, and variables that influence this maturity (Breytenbach *et al*., 2012). Variables that have a strong influence on projects aimed towards graduate development are (i) local ownership of projects (Avgerou, 2009; Coetzee, 2010; Heeks, 2008), (ii) the level of social embeddedness of projects (Avgerou, 2000; Pade-Khene, Mallinson & Sewry, 2011) epistemologically based on the work of Giddens (1984), (iii) the role of the media and social recognition (celebration) on project success (Chigona & Mooketsi, 2011), and (iv) the importance of focusing on direct and diffused increased in freedom (Sen, 1999) during development projects. Each of these variables was deconstructed into practical measures, with secondary questions, in the first section of the ISGDF.

The social sensibility of IS development projects might not come across as a logical starting point when constructing a graduate development framework. This article suggests that it is in this first group of variables that many a failed IS education project will find the reason(s) for its undoing. If a development project is not sustainably embedded into existing social structures, it will fail (Avgerou, 2009; Breytenbach *et al*., 2012).

4.2 IS labour supply and capacity building variables

An angle of approach to IS skills development that has received some attention in recent literature is the view that solutions to labour shortage problems can be found by informing IS literature with economic theories that address labour market failure – with theories such as human capital theory and labour capacity building theory frequently mentioned (Toner, 2011).

Following this approach of informing IS with labour market theory, the South African IS labour market situation was analysed within the neo-classical labour market framework of supply and demand (Breytenbach & De Villiers, 2012; Merkofer & Murphy, 2009). It became clear that there existed an insufficient supply of IS graduates and that the existing supply was very price inelastic in nature (Breytenbach & De Villiers, 2012). These findings meant that the task of solving the IS skills shortage was more complex than simply increasing the number of students (not an easy task by itself). The nature of the existing graduate supply needed to change to become a better "skills-match" with the industry demand of the day. By means of a large scale survey of 4475 students and

the construction of a graduate supply elasticity model through regression analysis (Breytenbach & De Villiers, 2012), education based variables that influence this elasticity [the skills matching nature] of IS labour supply were identified. When applied to projects that aim towards IS graduate development, these variables include (i) the project's focus on the industry readiness of students (Bridgstock, 2011; Flew, 2011), (ii) the projects ability to supply students with sufficient career and salary information (Calitz, 2011), (iii) the project's focus (or lack of focus) on scarce IS skills as subject matter (Cremer, 2011; MICT SETA, 2011), (iv) and the project's ability to leverage key motivational factors to influence student career choices (Breytenbach & De Villiers, 2012; Walstrom, Schambach, Jones & Crampton, 2008).

These variables were used to construct the second section of the ISGDF, as it made practical sense to measure (as a second important concern) how well each IS graduate development project was aligned with the IS skills shortage problem after measuring the project's social relevance in the first part of the framework.

4.3 IS education variables – syllabus, approach, and course structure

The third part of the framework was informed by literature that suggests IS education variables that influence IS graduate development projects.

Sen (2009) warns against the over-institutionalisation of development projects in favour of a more flexible approach called the realization based comparison approach. This distinction, as theoretical as it might sound, has far reaching implications (Breytenbach & De Villiers, 2013). It speaks to the nature of education based development projects, and explains how development potential (in our case, the ability to develop more high quality graduates) can be lost by overburdening short term solutions with institutional restrictions.

Recently, an argument from the literature was presented for short transition and reskilling courses as an education based solution to the IS skills deficiency (Breytenbach & De Villiers, 2013). Such short courses, it was argued, should include a far more comprehensive coverage of entrepreneurial skills [techniques] and a focus on innovation within core ICT and creative industries (Araya & Peters, 2010; Bakhshi & McVittie, 2009; Bridgstock, 2011; Cunningham & Higgs, 2009; Flew, 2011).

These variables – project institutionalization, the short course nature of projects, and the coverage of entrepreneurial skills – were used to construct the third section of the ISGDF presented later in this article.

4.4 Creative Industry and Employment variables

The fourth and final section of the ISGDF focuses on variables that relate to the ability of IS graduates to find employment in both the core IS industry – traditionally seen as including careers such as business analysis, systems analysis, systems architecture, data modelling, software development, and mobile application development – as well as the creative industries. The concept of a group of industries termed the Creative Industries has been thoroughly critiqued in literature, but has stood the test of time and the concept has recently been comprehensively defined in literature (Flew, 2011). This group of industries include (highlighted for the purpose of this article) design, mobile application development, game (software) development, and the use of technology within peripheral fields such as animation, film, architecture, and fashion design (Flew, 2011).

The framework presented in this article suggests that, if we are to counteract the growing IS skills shortage in South Africa, it is important that IS students are ready to work in both the core IS fields and as embedded labour within creative industries that make use of IS skills. Variables that measure the success of IS graduate development projects towards this end include (i) whether or not a project has trans-disciplinary focus/application (Banks & Deuze, 2009; Hearn & Bridgstock, 2009), (ii) whether a project develops [scarce] skills that can be applied in both core IS and creative industry occupations (Breytenbach & De Villiers, 2013; Bridgstock, 2011), (iii) a project's sensitivity to the unique business and policy challenges within the creative industries – such as intellectual property and copyright laws (Flew, 2011; Stolarick, Mellander & Florida, 2010), and (iv) whether a project results in measurable increases in the level of employability and/or entrepreneurial potential displayed by students (Breytenbach & De Villiers, 2013; Caves, 2003; Flew, 2011).

With pertinent literature relating to the presented framework now discussed, we present the graduate development framework in the next section.

5) The IS Graduate Development Framework

The task at hand is the creation of a framework that will guide new and existing education based IS development projects - that aim towards increasing the quality and quantity of IS graduates (and enrolments) – towards success. This framework should be comprehensive, covering influential variables from all the related (intertwined) fields of IS literature surrounding IS graduate development projects. The framework should also result in clear, ground level action points that will increase the graduate development capacity of IS departments using the framework.

Combining the variables mentioned in the literature review into one model resulted in a comprehensive framework with a high level of practical validity (discussed later as case study findings). Table 1 presents the IS Graduate Development Framework, and indicates how it has been constructed from literature (as part of the researchers' ongoing research).

	ICT4D project maturity variables	**Literature**
1	Diffusion/Integration maturity within budget	Leem *et al*., 2008; Sen, 1999
2	Social embeddedness/Local ownership	Avgerou, 2000; Avgerou, 2009; Coetzee, 2010; Giddens, 1984; Pade-Khene *et al*., 2011; Heeks, 2008
3	Media/Social recognition	Chigona & Mooketsi, 2011
4	Measurable increases in freedom (development)	Andersson, Grönlund & Wicander, 2012; Sen, 2000
5	Project/course/institution accelerating towards sustainably increasing the quality and quantity of ICT graduates	Breytenbach *et al*., 2012
	Labour supply/Capacity building variables	
6	Project/institutional focus on industry readiness (matching supply with demand)	Bridgstock, 2011; Lotriet *et al*., 2010; Merkoffer *et al*., 2009
7	Project/institution provides prospective students/graduates with sufficient industry career information	Calitz, 2011; Walstrom *et al*., 2008
8	Project/syllabus includes current scarce skills in subject matter (e.g. Java, C#, Mobile, SQL, BA)	Calitz *et al*., 2010; Cremer, 2011; ITWeb, 2011; MICT SETA, 2011
9	Leverages primary study choice motivators through long term involvement with (prospective) students	Breytenbach & De Villiers, 2012
10	Increase ICT labour supply through education	Breytenbach & De Villiers, 2012; Toner, 2011; Twinomurinzi, 2012
11	Increase ICT labour supply price elasticity through education	Breytenbach & De Villiers, 2012; Toner, 2011
	Course/syllabus structure variables	
12	Allows for realisation based comparison approach; Sufficiently non-institutional in nature	Sen, 2009
13	Industry is involved in identifying and filling scarce ICT skills gaps at the targeted level?	Breytenbach & De Villiers, 2013; Calitz, 2011
14	Takes form as short to medium length transition or reskilling course(s)	Breytenbach & De Villiers, 2013
15	Includes entrepreneurial/innovation soft skills in subject matter	Araya *et al*., 2010; Bakhshi *et al*., 2009; Bridgstock, 2011; Cunningham *et al*., 2009; Flew, 2011

	Creative Industries/Employability variables	
16	Project/course/institution has trans disciplinary application focus	Banks & Deuze, 2009; Hearn *et al*., 2009
17	Project/course/institution develops skills for core ICT industries	Breytenbach & De Villiers, 2012; Bridgstock, 2011
18	Project/course/institution develops ICT labour to be embedded in creative industries	Flew, 2011; Stolarick *et al*., 2010
19	Project/course/institution is sensitive to creative industry business/policy challenges	Caves, 2003; Flew, 2011
20	Course measurably increase students' employability for core ICT and/or embedded ICT careers	Breytenbach & De Villiers, 2013; Caves, 2003; Flew, 2011

Table 1: The IS Graduate Development Framework

Together with the combination of twenty key variables for graduate development project success, the ISGDF also incorporates the concept of the graduate development process as a supply chain – a group or groups of institutions – that produces IS graduates as deliverables. The IS graduate supply chain is represented by three such groups – secondary school institutions, diploma and graduate level institutions, and post-graduate and industry level institutions. This supply chain approach to labour supply is supported in literature (Calitz, 2011). The graduate supply chain starts at secondary school level. At this level it is possible to measure variables that will influence the number and the quality of tertiary level enrolments in IS (Breytenbach and De Villiers, 2012). The case study presented in the next section focuses on this part of the graduate supply chain – identifying problems as early as possible in the supply chain that produces [an insufficient amount of] high quality IS graduates. It is important to note that the framework was constructed with all level of the graduate supply chain in mind – secondary school, graduate school, and the post graduate level. The framework allows projects that focus on different levels of the graduate supply chain to be compared with each other in terms of their graduate development potential and impact on the supply chain. Stated differently, the framework can be used to identify areas for improvement across the entire graduate supply chain, not only at a tertiary level where it is often too late to address graduate development concerns. As we explain in the contribution section of this article, IS departments can use the framework to decide which graduate development projects should be given priority above others, based on measurable graduate development potential.

An explanation of how to use the framework presented in Table 1 is in order. The framework requires users to identify the area of the [IS graduate] supply chain influenced most by the project being measured, for example the secondary school level. Users should then fill in the framework with twenty Likert scale values between 0 and 5, with 0 being a poor score and 5 being a very good

score, to build up a final project score out of 100. This final score would be an indication of the measured project's potential to impact the graduate supply chain, developing high quality graduates in that subject field.

Although the user of the framework might be familiar with each of the twenty components of the ISGDF [and their measurement] from literature or practical experience, the actual task of measuring the graduate development potential of a project given the framework as shown in Table 1 would leave key considerations open for subjective interpretation – some of the twenty components are too complex to simply allocate a score between 0 and 5 to them without deconstructing them into measurable concepts. For this framework to work as a practical, ground level measuring tool of graduate development impact, each one of the twenty variables had to be deconstructed further into Likert scale measures that could be answered without ambiguity by project coordinators with a value ranging between 0 and 5. In the next section we present a case study that shows how each measure was broken down and used to generate the twenty key measures of the case study project.

6) Case study – The Mobile Application Development Challenge

The Mobile Application Development (MAD) Challenge is a short course structured as a competition for secondary school students. The primary goal of this course is to increase the quality and number of IS enrolments at the local university presenting the course. For a comprehensive discussion of the success of this course, see Breytenbach & De Villiers (2013). In its first year, the course showed promising signs of having a high level of graduate development potential – 30 of the initial 60 secondary school level competition entrants finished the course by completing their own mobile applications, each accompanied by a basic business case that could be used to measure the level of entrepreneurial potential being displayed by each student. Of the 30 finishing learners, 7 indicated that they have changed their career choices as a direct result of the course, and subsequently planned on enrolling for a degree with an IS major.

The MAD challenge was chosen as case study for this article for three reasons. First, the subject matter of the course included Java and mobile application development techniques – scarce skills that form part of the IS skills shortage we address with the ISGDF. Second, the course was structured as a short transition course that bridges the gap between IS education at secondary school level and tertiary IS studies, following suggestions from an earlier study (Breytenbach & De Villiers, 2012). Third, the project was structured as a competition, with the social development variables from the first section of the framework in mind. In 2013 the project expanded significantly, covering two

provinces in the catchment area of two local universities – an indication that changes made as a result of the 2012 framework application presented below, improved the impact of the project on the graduate supply chain.

In the following sections, we present the breakdown of each of the twenty sections of the framework, and show the measured results of the MAD project's graduate development potential.

The measured scores that we present in the following tables are the averages of the Likert scale scores allocated to the MAD project by each of the course administrators, two of whom were actively involved in the lecturing process and the competition judging process. The course administrators answered the 43 questions separately, after which the answers for each question were added and divided by the number of course administrators to attain an average score.

6.1 Section 1 – ICT for Development variables

Each of the five variables in the first section of the ISGDF (see Table 1) was deconstructed into three related questions using measures of these variables from the literature as guidelines. The results, with case study project measures, are shown in Table 6, presented as an appendix to this article. Table 2 summarizes the results for this section.

	ICT4D project maturity variables	**Average (/5)**
1	Diffusion/Integration maturity within budget	3.78
2	Social embeddedness/Local ownership	3.61
3	Media/Social recognition	4.33
4	Measurable increases in freedom (development)	3.06
5	Project/course/institution accelerating towards sustainably increasing the quality and quantity of ICT graduates	3.94

Table 2: Section 1 of ISGDF with case study measures

We now present a breakdown of each of the remaining three sections of the framework in similar fashion.

6.2 Section 2 – Labour supply and capacity building (supply) variables

Table 3 shows the second section of the ISGDF (see Table 1), with case study measures. A detailed breakdown of these values is presented as an appendix in Table 6.

	Labour supply/Capacity building variables	Average (/5)
6	Project/institutional focus on industry readiness (matching supply with demand)	3.25
7	Project/institution provides prospective students/graduates with sufficient industry career information	2.67
8	Project/syllabus includes current scarce skills in subject matter (e.g. Java, C#, Mobile, SQL, BA)	3.44
9	Leverages primary study choice motivators through long term involvement with (prospective) students	2.5
10	Increase ICT labour supply through education	3.67
11	Increase ICT labour supply price elasticity through education	2.72

Table 3: Section 2 of ISGDF with case study measures

6.3 Section 3 – IS education variables

Table 4 shows the third section of the ISGDF (see Table 1), with case study measures.

	Course/syllabus structure variables	Average (/5)
12	Allows for realisation based comparison approach; Sufficiently non-institutional in nature	3.5
13	Industry is involved in identifying and filling scarce ICT skills gaps at the targeted level?	2.5
14	Takes form as short to medium length transition or reskilling course(s)	5
15	Includes entrepreneurial/innovation soft skills in subject matter	2.33

Table 4: Section 3 of ISGDF, with case study measures

6.4 Section 4 – Creative Industry and Employment variables

Table 5 shows the fourth section of the ISGDF (see Table 1), with case study measures.

	Creative Industries/Employability variables	Average (/5)
16	Project/course/institution has trans disciplinary application focus	4
17	Project/course/institution develops skills for core ICT industries	4.33
18	Project/course/institution develops ICT labour to be embedded in creative industries	4.17
19	Project/course/institution is sensitive to creative industry business/policy challenges	1.5
20	Course measurably increase students' employability for core ICT and/or embedded ICT careers	4.5

Table 5: Section 4 of ISGDF, with case study measures

The complete breakdown of 43 questions, including course administrator scores and comments, are available as an appendix at the end of this article.

Adding the twenty resulting scores together gives the case study project a score of 68.8 out of a possible 100 points, translating into a secondary school level IS education project with a reasonably good graduate development potential [high impact on the graduate supply chain], but with evident room for improvement. The project's maturity rating of 3.74 out of 5 (taking the average of the scores in the first section of the framework - see the measures in Table 2) is good for a project that was only one year old at the time the 2012 measures were captured.

With a detailed demonstration of how the case study project was measured using the 43 questions that inform the twenty measures of the framework, we can now move on to an analysis of these results. In the next section we present findings resulting from using the IS Graduate Development Framework to measure the graduate development potential of the case study project.

7) Findings and discussion

We present the findings from using the ISGDF to measure the case study project in three parts. We start by discussing measures that the case study project excelled in, followed by a discussion of areas where the case study project could be improved. We end of with observations made while using the framework as measuring tool.

7.1 Case study project successes

In this section we focus on the framework measures for which the case study project scored more than 4 out of a possible 5, indicating them as success areas. These were measures 3, 5, 14, 18, and 20:

- Media/Social recognition
- Project/course/institution accelerating towards sustainably increasing the quality and quantity of ICT graduates
- Takes form as short to medium length transition or reskilling course(s)
- Project/course/institution develops ICT labour to be embedded in creative industries
- Project/course/institution measurably increase students' employability for core ICT and/or embedded ICT careers

Project coordinators used media coverage, social recognition (events, prizes, certificates), and the project's affiliation with the university to motivate participating learners. This and other good scores in section 1 of the framework gives enough ground to confirm that the project had already reached a level of maturity that is required for sustainability (Breytenbach *et al.*, 2012).

This project confirmed suggestions from earlier studies that investigated variables that could increase tertiary enrolments (Breytenbach & De Villiers, 2012) that short transition courses at secondary school level works well as graduate development tools.

With the focus of this course being mobile application development, high levels of creative and entrepreneurial outputs were observed. Mobile application development lends itself well to trans-disciplinary applications and to enhance the user experience in traditionally non-technical industries through mobile technology.

7.2 Improving the case study project

The case study project failed as graduate development tool in the areas measured by questions 4, 6, 7, 9, 11, 13, 15, and 19, as listed below.

- Project resulted in measurable increases in freedom (development)
- Project/institution/course focuses on industry readiness (matching supply with demand)
- Project/institution/course provides prospective students/graduates with sufficient industry career information
- Project/institution/course leverages primary study choice motivators through long term involvement with (prospective) students
- Project/institution/course increases ICT labour supply price elasticity through education
- Industry is involved in identifying and filling scarce ICT skills gaps at the targeted level?
- Includes entrepreneurial/innovation soft skills in subject matter
- Project/institution/course is sensitive to creative industry business/policy challenges

The case study project, being focussed on skills development at secondary school level, had limited opportunity to stimulate direct increases in freedom other than the expected increase in social freedom through access to information and education. If learners were to start making money as a direct result of apps that were developed during this course, economic freedom would be measurably increased, but at time of publishing no such cases had been reported.

One major failure of this course, one that shows up in several of the measures listed above, is the insufficient level of industry involvement during course creation, lectures, preparing learners for industry, and building long term relationships with industry. Industry involvement is a key success factor for graduate development projects.

Other important areas of concern include the project facilitators' failure to involve teachers and parents in the course, insufficient focus on entrepreneurial soft skills, insufficient examples of how the course material could be applied in trans disciplinary/innovative ways, and a lack of promoting Computer Application Technology (CAT) and Information Technology (IT) as secondary school subjects (a key variable in IS labour supply elasticity). IT an CAT are the two secondary school subjects that prepare learners for tertiary study in IS. Earlier results from a related study (Breytenbach & De Villiers, 2012) confirms the number and quality of IT and CAT students as significant variables in predicting IS enrolment numbers.

Preparations for the second year of the case study project were well under way at the time of publication in 2013. As improvements based on the project's ISGDF results, the new course included a significant increase in focus on industry readiness and entrepreneurial soft skills. The course has also been expanded to two courses – a junior and a senior course. The junior course, in particular, promotes CAT and IT as secondary school subject choices, and involves teachers and parents in the guidance of project work, while the senior course builds relationships between industry mentors and learners.

One improvement made to the case study project deserves our special attention. After evaluating the findings of the framework application on the case study project, a need was identified for a mobile application that could facilitate (i) information transfer from academics and industry to students, (ii) student access [mobile] to relevant industry career and vacancy information, (iii) direct marketing to prospective students by IS departments, and (iv) a working example of mobile application development applied in a non-core IS field (education). The researchers developed the mobile application as a tool that accompanies the ISGDF, further improving the graduate development potential of the case study course.

7.3 The framework as measuring tool

After an informal discussion of project variables, three course coordinators [two lecturers and one program manager] managed to complete the 43 questions posed in the framework with ease. It was observed that the framework becomes more nuanced as it progresses through the list of questions and that the current ordering of the questions into consecutive sections adds significance to answers given in the later parts of the framework - insights that might have been missed otherwise.

It is the combination of all these variables from different strands of IS literature into one graduate development measuring tool [framework] that result in practical value and the relevance of

framework – together these variables describe what is happening at an operational level and suggests practical steps for how graduate development can be improved.

8) Contribution and conclusion

The goal of this research is to counteract the growing IS skills deficiency in South Africa by presenting a framework for increasing the quality and quantity of IS graduates through IS education projects, and measuring impact of these projects on the graduate supply chain. In this article we presented the IS Graduate Development Framework (ISGDF), showed how to use it to measure the potential of IS graduate development projects, and discussed several findings that resulted from this measuring process.

The value of the ISGDF lies in its ability to translate high level development measures into practical steps that IS departments can take to improve the contribution their courses will make to graduate (or enrolment) numbers. We highlight some of the insights gained from actively using the ISGDF in a South African IS department by listing them below.

- Industry must be involved during course creation, syllabus content creation, and lectures to ensure industry readiness and the development of skills that match industry demand.
- Secondary school is the important starting point of the IS labour supply chain. A significant impact can be made on IS enrolment quality and quantity by supplying learners, teachers, and parents with quality information regarding IS courses, and promoting CAT and IT as subject choice.
- The media, and social recognition and celebration, plays a significant role in the social acceptance of graduate development projects.
- The creation of a mobile application that facilitates information flows between students, teachers, parents, and industry. The application also helps to further embed the course into social structures (aiding long term relationships and collaboration).

We conclude this article by answering our research question. With the ISGDF we present what we have found to be twenty variables that influence IS enrolment and graduate supply in one comprehensive framework. The IS skills shortage in South Africa can be addressed through IS education based projects that adhere to the requirements of the IS Graduate Development Framework.

9) Acknowledgement

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10) Appendix

	Score	Description
Question 1		
Was diffusion maturity (or a higher level of maturity) reached within budget?		
Observable indirect increases in economic freedoms?	3.67	Some students are now registered as merchants on the Google Play store / BlackBerry App World, creating entrepreneurial potential. The project resulted in changes in the department's marketing approach.
Observable indirect increased in social freedoms?	3.67	Schools and fellow learners benefitting from apps developed in this course; Increased understanding of career choices, and a greater range of career option available to students as a result of this course;
Was the project within budget when these observations were made?	4	Yes. Funding for the next year was not secured yet, so only a score of 4.
	3.78	
Question 2		
Did community members take ownership of the project? Was it socially well-embedded?		
Support from community members (incl. universities, schools, teachers, parents) for project?	4.67	The project was very popular with schools and IT/CAT teachers. Several schools asked to enrol students after capacity had been reached. Good attendance and understanding from schools and parents throughout duration of project.
Acknowledgement of project benefits and level of acceptance of perceived benefit and disruption caused by project?	2.33	Learners understood potential benefits of learning a new skill set, but some struggled to manage disruptions caused by examinations, lack of Java experience, and logistics.

Level of local ownership (of needed resources, motivation, and other) of this project?	3.83	The local university took full responsibility for the resources required to run this course. Parents and learners took full responsibility for their part of the costs and logistics. One school complained about travel costs and disruption during exam time.
	3.61	

Question 3

What was the influence of media coverage and social recognition on this project (and participants)?

Was there any recognition/involvement from high profile community members and/or academia for this project, and what was the level of impact of their involvement on learners?	4	A Professor, Doctor, and PhD student served as contacts and lecturers for this project, and this had a positive impact on learner perceptions. The project also benefited from being associated with the local university.
Any certificates, prizes, status, or other incentives linked to the celebration of success of learners? What was the level of impact of these incentives on learners/parents?	5	Certificates and expensive prizes were handed out at a prize-giving ceremony. Learners were invited to become part of the university's learner development program. Parents and teachers were invited to the prize giving.
Any local media coverage or recognition at schools, universities, or within community groups? The impact of these on learners/teachers/parents?	4	Three local news articles submitted, one published with photos of top learners with sponsors and university representatives.
	4.33	

Question 4

Did any direct, measurable development (increases in freedom) result from project?

Observable direct increases in economic freedoms	2.67	Department saves with targeted marketing approach, and with potential increase in quality and quantity of students (see statistics). Students in a position to start making money with apps immediately.
Observable direct increased in social freedoms	2.67	Learners now have wider range of skills, and increased access to career information
Was the project within budget when these observations were made?	3.83	Yes, but funding for a second year not secured.
	3.06	

Question 5		
Is this project moving forward, accelerating towards sustainably increasing the quality and/or quantity of students?		
Is there a positive difference between the current maturity level of the project and previous maturity measures? How significant is this growth?	4	The first year of the project completed successfully, with a high level of maturity for such a young project. Plans for an (improved) second year are in place.
Measurable increase in graduates, or potential enrolments?	3.67	Yes, measurable increase in potential enrolments
Measurable increase in the quality (aptitude, employability) of potential graduates, or enrolments	4.17	Yes, measurable increase in aptitude, and level of entrepreneurial potential
	3.94	

Question 6		
Does this project/course include a focus on industry readiness?		
Informed by industry needs analysis?	3.5	This project is informed by the industry analysis described in Breytenbach & De Villiers, 2012. Mobile application development as a scarce skill is discussed during lectures, and ITWeb stats were mentioned in class.
Input from industry stakeholders?	2	Minimal. BlackBerry supplied some of the course content and incentives, but the project lacks in this regard. The lecturers did inform some of the sessions with industry related examples.
	2.75	

Question 7		
Does this project/course provide students with sufficient career/industry information?		
Did this course include a measurement of student career knowledge and career motivation towards ICT/IS?	4	Yes, the career choices and motivations of students were measured before and after the course

Were students thoroughly informed about career options related to the course (during or after course)?	2	Students were told about the entrepreneurial potential of mobile app development, but they were not made aware of any specific industry gaps, needs, or current vacancies
Did this course satisfy the students' and/or parents' information needs regarding potential fields of study?	2	No. Discussions took place, but all the questions weren't answered. More brosures, yearbooks, etc. could have been made available to students and parents.
	2.67	

Question 8

Does this project/course include current scarce skills in subject matter?

Scarce skills covered at satisfactory level (depends on which part of the supply chain this course is aimed at)?	4	Yes, Java, and Mobile Application Development using Java was covered during this course, at a high level of difficulty.
Did students manage/master the course content within the given time period?	2	About half of the students managed the course workload well. The Java was to difficult for many of the younger learners, but they enjoyed applying programming in a mobile environment - this is one of the main areas for possible improvement of this course.
Was there sufficient (and aptly trained) staff members available to present this course at the required level?	4	Yes. The number of tutors might be increased, as the younger learners need more hand-holding with the Java.
	3.34	

Question 9

Does this project/institution leverage primary study choice motivators through long term involvement with (prospective) students?

Does the course structure facilitate long term lecturer relationships with students?	4	Yes, the course is specifically designed to be long enough to facilitate meaningful relationships between lecturers, tutors, and students. These relationships can be used to influence career choice variables.

Does this course leverage the long term relationships of parents and teachers with students to influence career choice variables?	1	No, not at all. This is a area for improvement.
	2.5	

Question 10

Does this project result in a dirent increase in ICT labour supply (graduates or enrolments) through education?

Increase in graduates or enrolments?	4	This is the main focus of this course - to increase the pool of high quality, apptly skilled secondary school learners that will enrol for tertiary level IS study
	4	

Question 11

Does this project result in an increase in ICT labour supply elasticity (variables in Breytenbach & De Villiers, 2012 findings)?

Does this course increase industry knowledge and inform student perceptions regarding salary expectations to the degree that they can make well informed career decisions?	3	Yes, but as mentioned in question 6, much more can be done in this regard.
Does this course build long term relationships between learners and motivators? Between learners and industry?	2.5	Yes, but as mentioned in question 9, much more can be done in this regard
Does this course promote IT and CAT as secondary school subjects?	2	No. IT and CAT were mentioned as one measure on the course application form, but this was not a pre-requisite. The second year project plan includes active attempts to promote IT and CAT with younger learners.
	2.5	

Question 12

Does this project/course structure allow for realisation based comparison approach to filling identified ICT skills gaps; ie. Is the project sufficiently non-institutional in nature?

Does the course/institution structure allow for year-on-year changes to course content and major sylabus changes?	4	Yes, but this flexibilty is only obtainable because of the flexibilty of the secondary school learners. If this course becomes part of a tertiary degree program, it will take effort to maintain this flexibility in approach.
Did the course content change towards industry needs during the last year?	3	Changed were made in the sylabus between year 1 and year 2, towards including Android as popular mobile app development platform.
	3.5	

Question 13

Industry is involved in identifying and filling scarce ICT skills gaps at the targeted level?

Internships, or similar programs for promising students?	3	Industry did follow up the project with prizes and field trips for school learners. No internships or holiday work.
Industry actively involved in sylabus setup?	2	No. Some BlackBerry content were used, but the BB content are not aimed towards secondary school learners - content had to be readjusted, and informed with several basic Java sessions.
	2.5	

Question 14

Is this a short course focused on the transition or reskilling of students towards ICT employment?

Transition or reskilling course?	5	Yes. This course is focused on the transition of secondary school learners to tertiary level IS students - filling in skills gaps that might hinder this transition
	5	

Question 15

Does this course include entrepreneurial/innovation soft skills and examples in course content?

Entrepreneurial soft skills (networking, industry analysis, presenting ideas, brainstrming sessions, small group collaborations sessions)?	3	Yes, students had to work in small groups structured as small entrep. business teams. Business ideas had to be developed. Soft skills did not receive nearly enough attention.
Examples of entrepreneurial application	2	Very few examples were given.

of knowledge discussed in class?		
	2.5	

Question 16

Project/course/institution has transdisciplinary application focus?

Does this course focus on applications outside the core ICT industries?	4	Yes, strong focus on how to use mobile application development in other areas of interest, personal aptitude, eg. medicine, finance, education, social.
Any successful transdisciplinary applications as a result of this course?	3	Yes, even at secondary school level good transdisciplinary applications (and good business ideas) were generated as direct result of the course. See findings of Part 3 for details.
	3.5	

Question 17

Project/course/institution develops skills for core ICT industries in scarce skill areas?

Can the skills that are developed in this course be used during employment in the core ICT industry?	4	Yes, mobile application development and its grounding in Java and XML can be used in core ICT employment. The application of these skills will increase a student's employability in core ICT positions.
	4	

Question 18

Project/course/institution develops ICT labour to be embedded in creative industries?

Can the skills that are developed in this course be used during employment in the creative industries?	4.5	Yes, mobile application development and its grounding in Java and XML can be used during creative industry employment. The application of these skills will increase a student's employability (and entrepreneurial potential) within creative industry context.
	4.5	

Question 19

Project/course/institution is sensitive to creative industry business/policy challenges?

Are Creative Industry business models discussed in this course?	2	Only as far as registration of mobile application merchants and making products available online. Much more information can be made available in this regard, as this will influence the level of entrepreneurial potential directly.
Are Creative Industry policies, such as copywirte, distribution agents, and industry regulations discussed as part of this course?	1	No. Copywrite was discussed once as a response to a student's question.
	1.5	
Question 20		
Project/course/institution measurably increase students' employability for core ICT and/or embedded ICT careers?		
Was an increase in employability measured as a result of this course?	4.5	
	4.5	

Table 6: Expanded Sections of ISGDF with case study measurements.

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7.3 End notes – Part 4

In this section the researcher presents the motivation for and functional specification of the mobile application that was developed in order to facilitate the outcomes of the IS Graduate Development Framework (ISGDF) measurements within the IS department of a local university.

7.3.1 Practical implementation of the ISGDF

In the previous section of Chapter 7, the researcher identified the following list of possible improvements that could be made to ensure an increase in graduate development potential in the case study project [and hence, other similar courses].

- Project results in measurable increases in freedom (development)
- Project/institution/course focuses on industry readiness (matching supply with demand)
- Project/institution/course provides prospective students/graduates with sufficient industry career information
- Project/institution/course leverages primary study choice motivators through long-term involvement with (prospective) students
- Project/institution/course increases ICT labour supply price elasticity through education
- Industry is involved in identifying and filling scarce ICT skills gaps at the targeted level
- Includes entrepreneurial/innovation soft skills in subject matter
- Project/institution/course is sensitive to creative industry business/policy challenges

Taking these points in order, a brief description of how to associate each of these needs for improvement with the concept of a mobile application follows. This will explain much regarding the design approach to the mobile application, discussed later in this chapter.

Mobile applications make it possible to measure user activity at a detailed level. One could, for example, measure the number of times a student views academic content or participates in an academic online forum – measures that would provide the means with which to conclude whether or not an increase in freedom has occurred within a group of students, be it access to academic content, or access to social structures that promote learning. *Mobile applications can help us measure development*.

Mobile applications make it possible for course-specific, and industry sector-specific, information to be available on each student's mobile device. The educational convenience of such applications has been covered in the literature, but the ISGDF points out another important use of this functionality –

giving industry access to students via their mobile devices. As the reader will see in the next section, mobile applications allow industry stakeholders the opportunity to market and recruit for vacancies (or for retail benefit) towards a target population that would otherwise have been unreachable and far more heterogeneous. *Mobile applications can bring industry into the classroom*.

Mobile applications can serve as a focussed marketing tool for IS departments, for both secondary school learners and existing students. Departmental courses, events and administration can be facilitated via mobile applications, with students receiving immediate notifications of any new content. *Mobile applications can build relationships with prospective students*.

Finally, the use of mobile applications during the facilitation of an academic course forces students to engage with new technologies with a high entrepreneurial potential. Students become aware of how mobile applications change their experience of academic learning and, with guidance, translate the concept of mobile application development into their own innovative applications.

In the next section the researcher presents extracts from the functional specification of the alpha release version of the ISGDF-informed mobile application that was developed for use during study-related 2013 lectures.

7.3.2 The application

This section focuses our attention on the design and functionality included in the mobile application that the researcher developed to form part of the ISGDF package as the contribution of this research.

First, a few notes regarding programming aspects of the mobile application development process. The application was developed by the researcher, using Eclipse [Juno Release] for Windows as development environment. The application was first developed for the Android platform and later ported to the BlackBerry platform in order to cater for a larger audience. Developing software for the Android platform can be done using several different languages, but it was decided to work with the most commonly used Android programming languages – the widely accepted Java/XML blended structure for Android, commonly referred to as *native* Android development. This decision made it possible to port the application to the BlackBerry platform (for use on BlackBerry 10 devices and newer), as the software used for porting applications from Android to BlackBerry only works for Android applications written using the Java/XML standards for Android. More specifically, porting only works for Android applications developed for the Android 2.3.3 Application Programming

Interface, also known as API 10 or Gingerbread, using Java and XML as languages. The porting software was tested for compatibility with later releases of the Android API, and it seemed to work, but BlackBerry did not guarantee any forward compatibility with newer versions of Android at the time this text was published. There is a reason for BlackBerry limiting compatibility with Android API 10. This was the last stable build of Android that allowed network access (and internet connectivity) from the main thread of the application – the actual user interface thread. BlackBerry allows connections from the main thread as well, but would have difficulty running applications that were designed using multiple threads for later [newer, more advanced] Android APIs.

One more note on the development environment, Eclipse, is in order. Eclipse is available for Windows, Mac OS (Apple computers), and some distributions of Linux, including the popular Ubuntu. Eclipse is shipped with some versions of Ubuntu. This cross-platform accessibility makes it a very popular development environment, and could be one of the reasons for the exceptional uptake of Android mobile application development within the software development community – it is free, and works with acceptable ease on most platforms.

Before looking at functional elements of the application, mention must be made of the most important design requirement of this application. The application had to be free and make use of no proprietary software during its development, with the exception of the Microsoft Windows operating system.

Following this design prerogative, the application was developed to be completely generic [applicable to as many courses as needed] and free – the researcher had to be able to make the application available for free, for use in several unrelated academic short courses. This was no easy task, and required detailed knowledge of several mobile and web technologies. The application combines several existing open source technologies into an application that makes it easy to maintain by lecturers without losing any of the desired functionality listed in the previous section.

7.3.2.1 Functionality

When a user downloads the application from the Google Play Store (for use on Android devices) or the BlackBerry App World (for use on BlackBerry devices), they see the application as part of their list of applications that are installed on the device – see Figure 12. The case study project for Part 4, MAD 2012, adjusted for 2013, was used as example during the screen images that follow.

Figure 12: Application installed on device

When the user touches the application logo on the screen, a title page appears in the form of a splash cover that fades in and out of view. The title page is followed by an initial marketing screen designed to be utilised by IS departments to promote applicable courses and/or material. See Figure 13 as example of these screens.

If the user wishes to see more information regarding the IS department concerned, the screen can be touched during the viewing time of the marketing screen. This action will guide the user to a website of the IS department's choice, by using the device's browsing intent(s). (See Figure 14.)

Figure 13: Title page (splash) and IS Department information screen

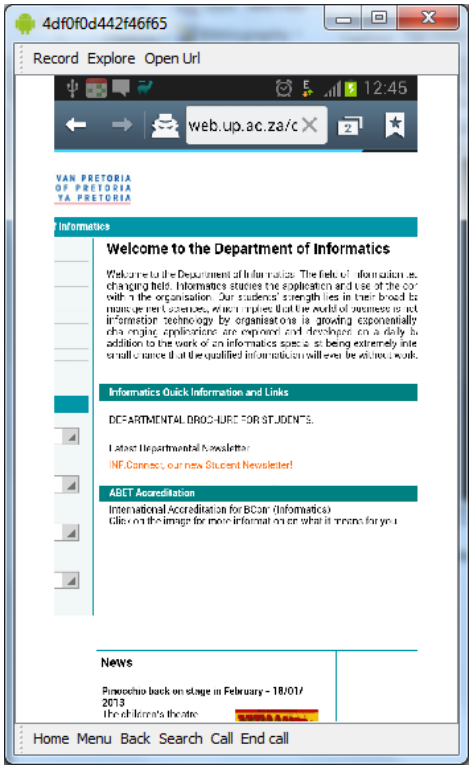


Figure 14: Automated browsing to departmental webpage

If the user allows the application to finish loading, not touching the marketing screen, the main menu screen is presented to the user next (see Figure 15). On this screen, menu options that facilitate both industry-learner communication and lecturer-learner communication are presented to the user. These options include viewing the course outline, weekly notes, relevant Twitter feeds, Facebook feeds, additional course information, information regarding textbook sales, and direct access to the lecturer via email. The screen also contains a "share" button that facilitates sharing news regarding the application via several popular new media-sharing applications, including Facebook, Gmail and Twitter.

Figure 15: Main menu screen, with sharing capability

Some of the menu options on the main menu deserve further attention. If the user selects the Weekly Notes and Blog News option, s/he is redirected to a page listing all available news items and notes posted to a blog that is related to the course, displayed in typical blog format – reverse order. (see Figure 16).

If the user touches one of the listed news items on the screen, the application guides the user to the relevant blog post in mobile display format. (See the second picture in Figure 16.)

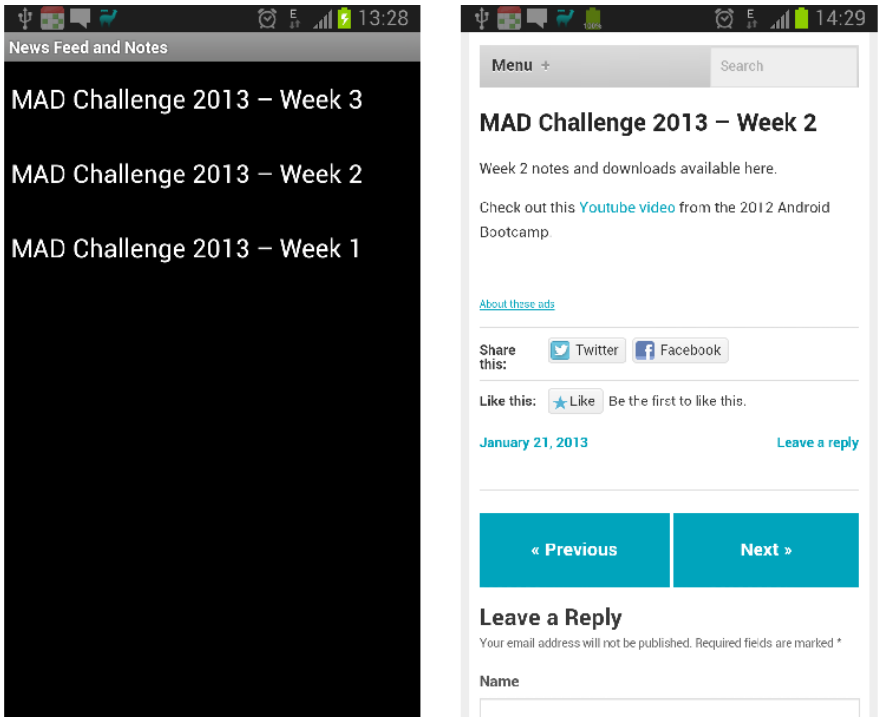


Figure 16: Weekly notes available as a live blog feed

Many education-focussed mobile applications require the sharing of media content – images, videos and audio files – with students in a format that is acceptable to most mobile devices. The application was designed in such a way as to interrogate any files that were linked to the selected blog post (news article) and to give the user the option to view these files using only applications that are working on the current user's mobile device. If the post that was selected in Figure 16 is used as example, a YouTube video can be seen linked to this post. Notice that this post can be shared using social networking sites. If the user touches the YouTube video link on the screen, indicating intent to view this video, options for viewing video content are presented to the user – options that are customised to the device in use. (See Figure 17 as an example.) The device we used for the screen images facilitated two ways of viewing YouTube content – via the browser (display was automatically adjusted for optimal viewing of the mobile site) or via the devices installed instance of the YouTube application. This functionality can be used to guide the user to industry- or company-specific media content without having to redevelop the content for use on mobile devices.

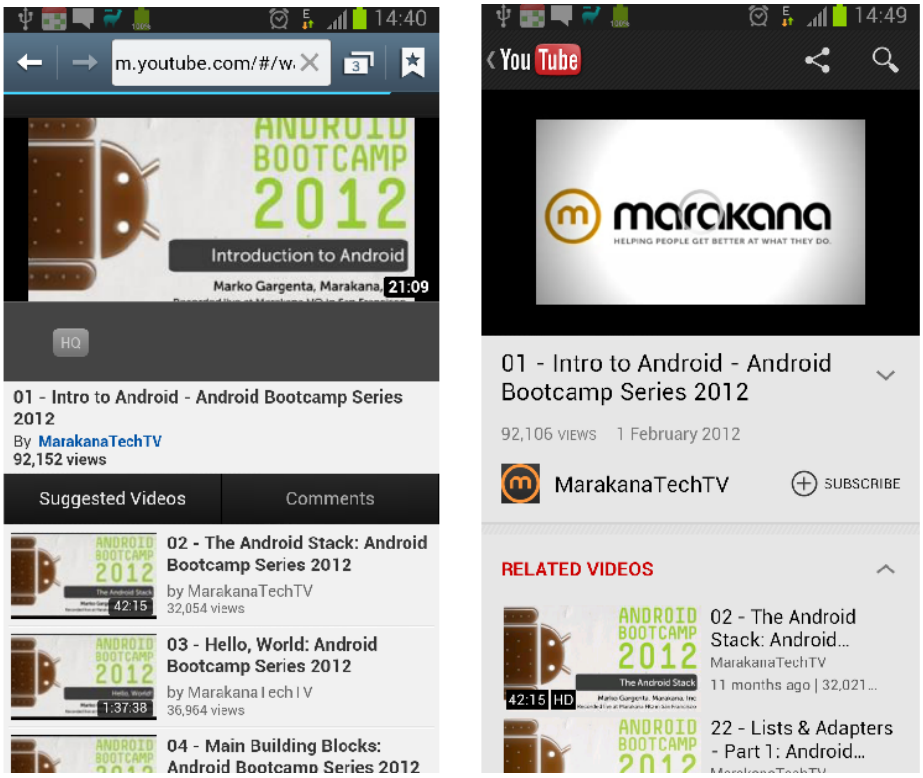


Figure 17: Viewing multimedia course content

Moving to the other main menu options, the user can decide to view Twitter feeds that are relevant to the course. This functionality was difficult to add to the application – the Twitter API is strict regarding mobile connections – and most of the functions are already available to the user via the Twitter application on the user's device. The same can be said for the Facebook integration – it was possible, and the researcher completed the integration, but the functionality falls short of that provided by the official Facebook application available for Android devices. The application, similar to the mentioned Twitter and Facebook applications, can give the user notification of new messages or news that becomes available in the application.

As an example of industry-specific content provided to students, there is a menu option for viewing the availability of textbooks related to the course [from a popular textbook retailer[25]]. In a similar fashion, vacancy information and direct marketing content of industry stakeholders can be made available to students. Students will be guided to vacancy-related websites when interacting with the direct marketing content on the screen.

[25] Van Schaik Bookstores name and logo used with permission, 2012-2013.

7.3.3 Future development

It is important to reconsider the researcher's motives for developing the mobile application described in the previous section. Based on the findings in Part 1, 2 and 3, the researcher wanted to facilitate relationships and share course and vacancy information. The application will have to undergo a year of practical testing to ensure that these goals have been met – the researcher is confident that the application will succeed in facilitating the changes suggested by the IS Graduate Development Framework.

One major improvement planned for the next version of the mobile application is calendar integration. A lecturer should be able to import a Google calendar into the application, and then push it to the native calendar application on the device, ensuring that the users will receive notifications regarding important events timeously. At the moment this functionality is being mimicked by creating Facebook events and having the device's native Facebook application serve notifications to the user.

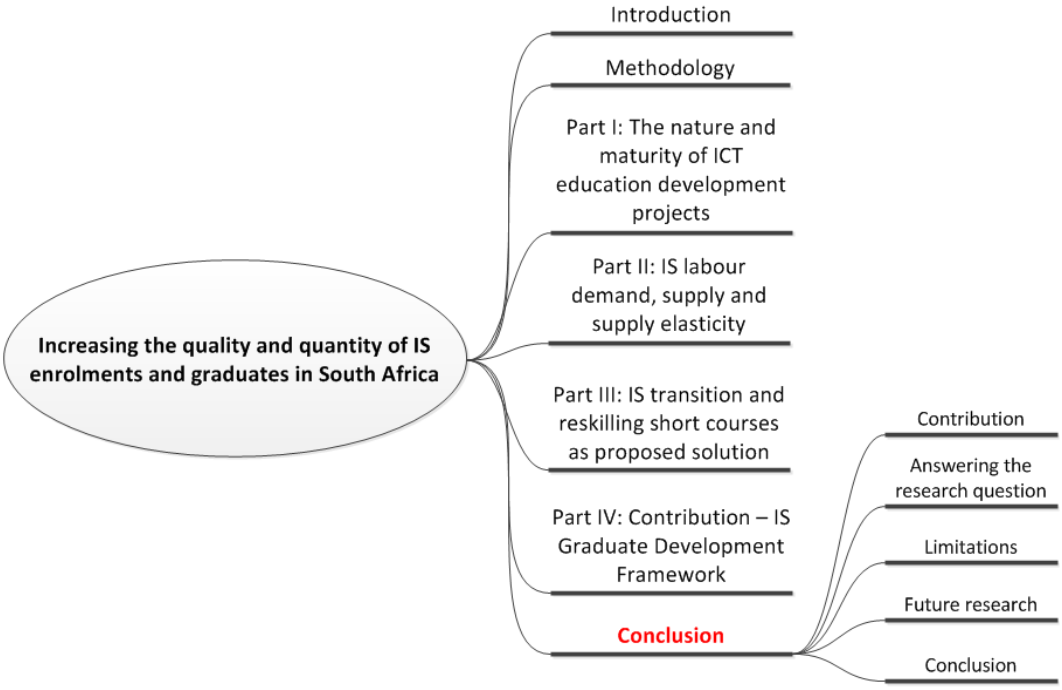
Anyone can download the application. It is free, and will be made available on popular application portals – Google's Play Store and the BlackBerry App World. Users could include headmasters, teachers and parents. From a development perspective, the researcher suggests promoting the use of the application by these [previously excluded] user groups. The application was structured [designed] in such a way that it gives these groups of users access to discussion forums and social networks related to the course – the same access provided to students. The free, open nature of the relationships built via the mobile application will hopefully facilitate discussions between students and long-term motivators (teachers, parents) regarding the value of IS courses and IS as a career option.

To summarise - the presented mobile application facilitates some of the core graduate development concepts suggested by the IS Graduate Development Framework.

7.3.4 Appendices

A selection of code files (Java and XML) from the development library for the mobile application is presented in Appendix 5.

CHAPTER 8: CONCLUSION



In this chapter the research cycle is completed by returning to the themes that prompted this work after being stimulated by preliminary reading and answering the research question(s) posed at the outset of this study. The now familiar concepts of development as increases in freedom, media influence, the IS skills shortage, the creative industries as additional avenues towards employment, mobile application development as a tool for increasing employability and the entrepreneurial potential of students are revisited; a deeper understanding of these concepts is discussed as part of the contribution. The contribution of this study, however, goes beyond an understanding of these themes, and therefore this chapter highlights some of the insights gained by the researcher from being involved in this study for several years.

After summarising the contribution that this study made to the IS body of knowledge, the researcher answers the research question of this study, acknowledges limitations in the research approach, and suggests avenues for future research that can benefit from the contribution made by this study.

8.1 Contribution

8.1.1 Understanding the IS skills deficiency and IS graduate development

This thesis brings together several considerations from the literature and a significant amount of practical research results in the form of a framework that explains the complex nature of the IS skills deficiency (Part 4). Going beyond the researcher's understanding of the IS skills shortage – which was covered from both a supply chain and a labour market perspective – this thesis makes a knowledge contribution to our understanding of the types of projects that can be used to optimally address the IS skills shortage. Such projects (courses/initiatives/institutions) should:

- be administrated [and facilitated] towards reaching the "diffusion" level of maturity within budget (before donor funding is depleted)
- show an understanding of social embeddedness and local ownership, actively working towards local ownership of the project
- understand and make use of the positive influence of media recognition and social celebration
- aim towards measurable increases in freedom (economic, social, political, securities) of the participants as primary development output

- be accelerating towards a level of maturity that ensures sustainability of the development outputs
- focus on the industry readiness of participants, matching skills supply with industry demand
- provide participants with sufficient, current IS career [occupations] information, including salary expectations and vacancy information
- include current scarce IS skills in subject matter [project focus]
- make use of primary study choice motivators [parents, teachers, personal interest] to attract younger learners and unemployed graduates to IS careers by leveraging the influence these motivators have on students
- have a clear understanding of how the project/course/institution can increase IS labour through education
- have a clear understanding that the type and quality of student must match industry expectations, in order to increase the price elasticity of IS labour supply
- not be overly burdened with institutional requirements, but rather follow a realisation-based comparison approach (focusing on attaining the largest possible short-term increases in freedoms)
- encourage industry involvement in syllabus construction and training delivery; industry stakeholders can identify skills gaps at the targeted labour supply chain level
- be structured as short to medium-length transition or reskilling courses
- include a focus on entrepreneurial [innovation focussed] soft skills in the subject matter [course content]
- make students aware of the possibilities for trans-disciplinary applications of their IS knowledge/skills
- develop skills that can be used both in core ICT industries and creative industries, with the aim of broadening the scope of possible occupations a student can choose from and increasing the students' employability across this broader spectrum of career choices

- make students aware of the unique business, policy and technical challenges that exist within the creative industries
- focus the attention of students, their motivators and industry partners on how freedoms within the local community can be increased with the application of newly developed knowledge/skills

The researcher found sufficient proof indicating that education-based IS graduate development projects can address the IS skills shortage, if these projects combine [now proven] key success factors from (i) social/community development literature, (ii) labour market and capacity building theories, (iii) IS education literature, and (iv) industry readiness knowledge in the creative industry literature, as listed above. These desirable IS development project attributes, as presented above, were combined in the IS Graduate Development Framework, discussed in Part 4. See Figure 18 for a diagrammatic view of how the IS Graduate Development Framework not only informs the reader's understanding of the IS skills debate, but also informs the nature of solution projects.

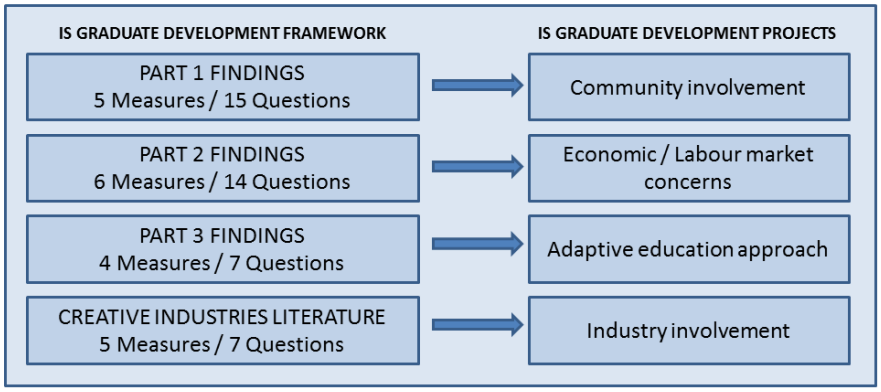


Figure 18: The ISGDF influences our understanding of projects that offer e-skills solutions

Projects with the potential to resolve the shortage of IS graduates and enrolments in South Africa should include informed [thoughtfully constructed] community involvement aspects, be aware of the education-based variables that change labour market conditions, and follow flexible, adaptive education delivery approaches while making sure that actual industry needs are being addressed by involving industry stakeholders in the education delivery process. Industry, in turn, benefits from having a closer relationship with the graduate supply chain, which allows industry stakeholders the

opportunity of involving graduates in their value chains during industry readiness education – even before the students graduate and become part of the IS workforce.

The researcher's understanding of the type of project that could be used to address the IS skills shortage in South Africa evolved as this study progressed. This understanding has moved from (a) the comprehension that such projects should be socially embedded, focussed on increasing freedom, and nurtured towards maturity, to (b) the ISGDF-informed view that such projects should also [above and beyond our previous understanding] be informed by labour market conditions, an adaptive [not overly institutional] education approach, and industry involvement. See Figure 19 for a simplified presentation of what the researcher views as an ISGDF-informed IS graduate development project.

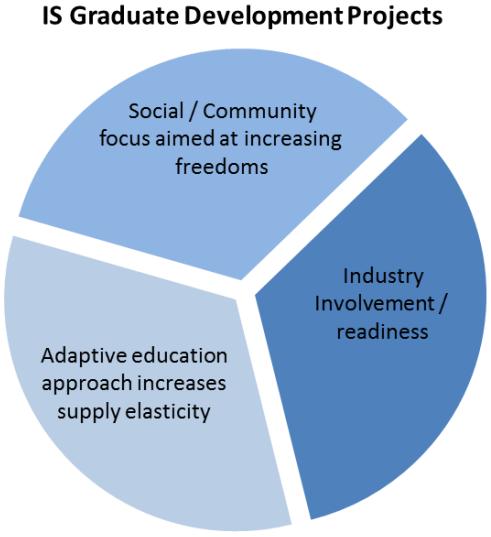


Figure 19: ISGDF-informed development projects

During the 2012 e-skilling debate, the term "ecosystem" was frequently used to describe the environment in which IS skills development should take place – an environment that includes community members, educators and academic institutions, and industry partners (Mitrovic, 2012).

Being actively involved in e-skills conversations throughout the period from 2010 to 2013 period regarding how such an ecosystem should be built, the researcher was partisan to many fruitless discussions of stakeholder agendas that either did not have e-skilling as primary agenda, or did not have the necessary underpinning relationships in place to focus the conversations on the issue at hand – creating an ecosystem in which the skills of IS students could be increased so that local community and local business skills needs [IS needs] could be addressed. These [negative]

experiences convinced the author that some e-skilling conversations matter because they can potentially enhance lives, and, by implication, some other e-skilling conversations do not matter, as they are not grounded in community and/or business needs. An explanation of this notion is provided in the next subsection.

8.1.2 Conversations that matter

From the results chapters of this thesis it became clear that IS graduate development projects involve a larger group of stakeholders than just IS educators. At recent (2012-2013) e-skills workshops and colloquiums, a variety of industry, government, academic and community representatives joined in complex discussions regarding solutions to local and continental e-skills shortages. With so many stakeholders, many of whom rely on their local government for funding, participating in a discourse that is sparsely funded, the possibility exists for conversations to become counterproductive. Common ground [a shared agenda] between stakeholders becomes hard to find. It becomes hard to align the expectations of all the parties involved in the e-skilling debate.

The knowledge contribution of this thesis assists this IS skills deficiency debate by implicitly urging all stakeholders to focus their attention on applying skills such as mobile application development to conversations that matter to both local communities and local businesses. The common ground in IS skills development *is not* the potential economic growth that will result from higher levels of skilled labour participating in industry (Avgerou, 2000, 2003), even though this might be a primary motivator for funding stakeholders.

The common ground between these stakeholders is community needs that can be met by industry - above the profit margin, if educators could supply appropriately skilled IS graduates that have an understanding of these community and industry needs.

Some examples of the e-skilling conversations that matter are in order. Conversations regarding local health issues [pregnancy prevention, awareness and management of HIV/AIDS], local crime problems [sending anonymous information to police, reporting gang-related violence], local transport problems, sewage management, conservation and responsible citizenship, and the IS solutions to these problems – these conversations matter. Such conversations, at all levels of the e-skills debate, bring together stakeholders in a network that translates into a favourable value proposition for all. Such conversations, more importantly, must make their way into e-skilling classrooms, as knowledge of these conversations [needs expressed by community and local businesses] will significantly increase the employability and industry readiness of students. See

Figure 20 for a visual representation of the relationship between IS graduate development projects and conversations that matter.

The view shown in Figure 20 is supported by ongoing operational work done by Craffert[26] regarding e-centres and e-skills hubs and how these centres can be used to identify real [realistic] local community and local business needs. This work is summarised in Figure 21, as presented to e-skills stakeholders in 2013[26].

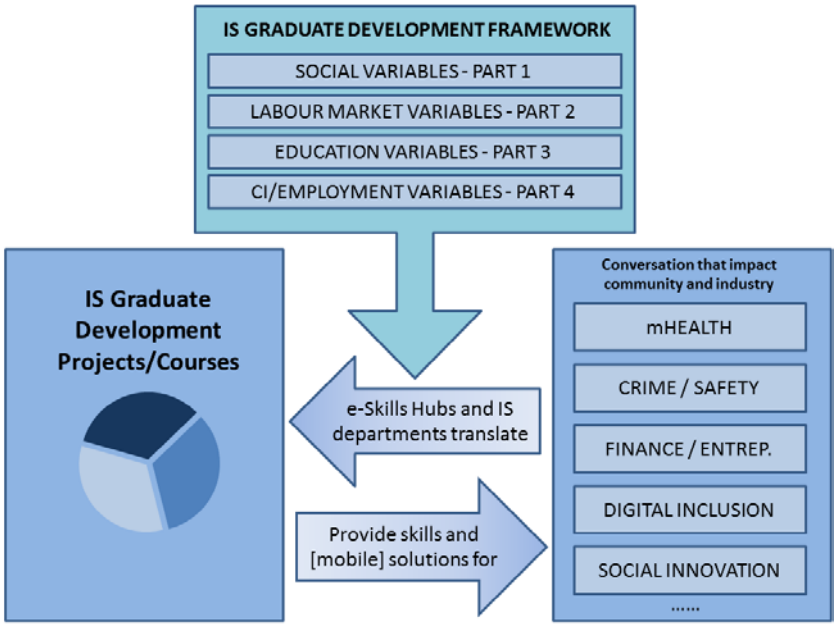


Figure 20: ISGD projects focussed on social and business needs

Mobile application development hubs should focus on developing applications together with industry partners that solve community problems (which in many scenarios translate into government concerns), rather than focussing purely on increasing the quantity of skills available to industry. This statement might seem to disagree with statements made earlier in this text regarding increases in the quality and quantity of IS graduates, but the researcher argues that merely increasing graduate numbers will not help at all if these graduates are not prepared to step into difficult, problematic local community scenarios in need of IS skills.

[26] Used with permission of Leona Craffert – as presented at a e-SI Stakeholder meeting in February, 2013.

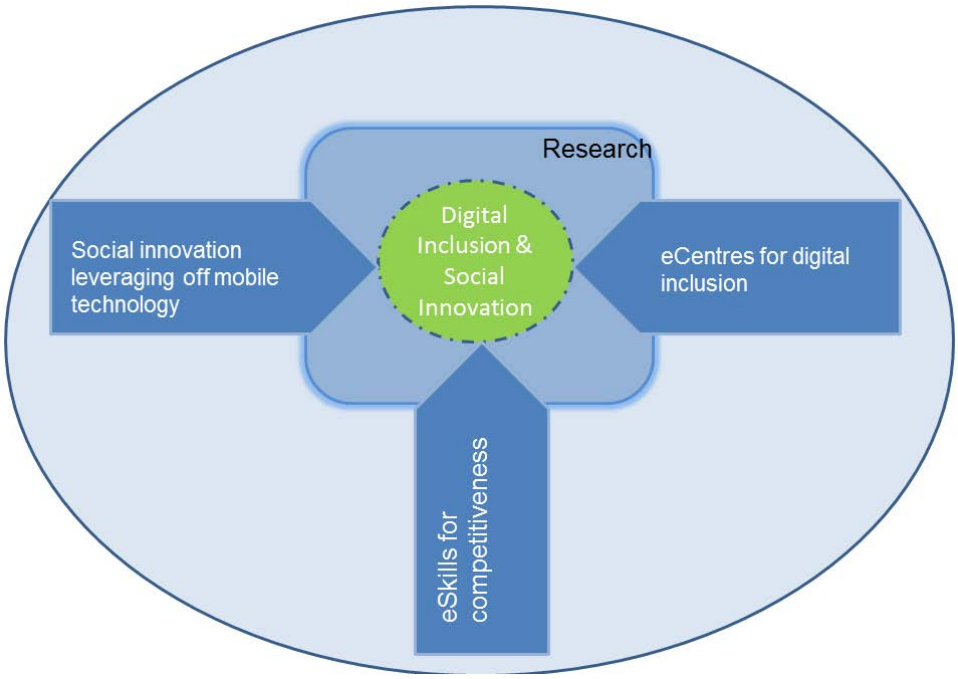


Figure 21: The role of e-centres in defining and facilitating conversations that matter[26]

In March 2013, the revised National e-Skills Plan of Action (NeSPA, 2012) was released for comment. This document contains the work of Mitrovic (2012) on the creation of an e-skills ecosystem, as summarised in Figure 22. This representation of what a successful e-skills landscape should look like agrees with the findings of this thesis. The role of the IS education projects discussed in this text can be seen to be a relationship between business and civil society, as shown in Figure 22, while being informed [and informing] government, global partners, and organised labour.

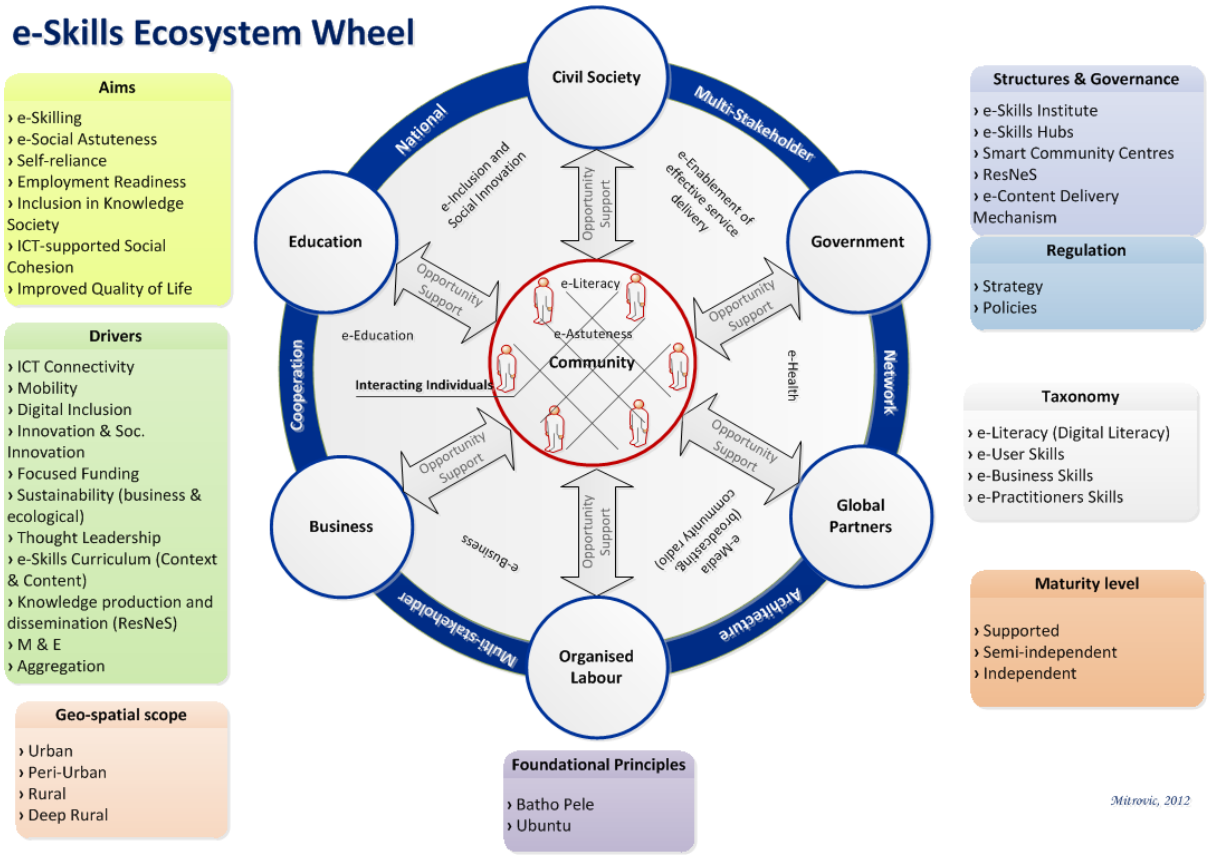


Figure 22: e-Skills Ecosystem Wheel, from Mitrovic (2012)

The abovementioned understanding of the IS skills shortage landscape, probable solutions, and the complex relationships between stakeholders in this context, has been critically constructed from several streams of IS literature. Some themes from these literature sources have presented themselves as being key in the investigation of IS graduate [and enrolment] development; therefore they receive mention again in the following subsections as explicit constituents of the contribution.

8.1.3 Development as freedom

This study started as a critical review of the maturity and sustainability of ICT-enabled community development projects that influence IS graduate development. Where the study has progressed beyond its original intentions of presenting a socially sensitive critique of such projects, the study's unassuming starting point in development literature provided a solid foundation on which a solution for IS skills shortages could be built. One of the definitions in this theoretical foundation has guided the researcher's understanding of development throughout this text; the definition of development as increases in the freedoms of individuals and communities (Sen, 1999). The influence of this

definition is evident in the first section of the IS Graduate Development Framework presented as the contribution of this study.

IS graduate development projects should focus on increasing the freedoms of individuals and communities – beyond the direct freedom increases they provide for students receiving IS education. Such projects should stimulate the application of technology to urgent community and business needs – to conversations that matter, as discussed in the previous section. This thesis ended up focussing primarily on the role that mobile application development can play in this "increasing social and economic freedom" context, but the researcher acknowledges that the role that IS graduates have to play in furthering the use of technology in society and business extends well beyond the development of a few mobile applications. Mobile application development courses were used as example of working IS graduate development projects that have an impact on society whilst simultaneously addressing IS skills gaps.

8.1.4 Media

The role of the media in IS graduate development is a field of study that requires more research. In Part 1 of our study, the positive role of media exposure on the level of community ownership of ICT projects was mentioned. In Part 2, again, the role of the media in shaping the perceptions of prospective IS students while they consider the range of occupations as potential future careers was discussed. The researcher also alluded to the idea that parents and teachers are influenced by media's presentation of IS careers, rather than being informed by more knowledgeable sources such as universities and faculty. In Part 3, mobile applications, including social media and public media applications, were mentioned as a suitable subject for short transition and reskilling courses. In Part 4 the researcher presented the concept of IS professionals embedding themselves in creative (media) industries, furthering the influence and role of the media in the community and business concerns mentioned above. Throughout this study, the media's influence on IS graduate development concerns has been observed, but this relationship has not been reduced to its essence. The role of the media in IS graduate development cannot be denied, but further [critical] investigation of this influence is required.

8.1.5 Towards employment in the creative industries

An important conversation within the e-skills debate that has only recently received attention in the literature is the reality that a portion of IS (and ICT) graduates end up working outside the core technical industries that traditionally employed almost all of them. The creative industries, in

particular, seem to be employing an ever larger portion of IS graduates. Moreover, it seems that students gifted with multidisciplinary skills sets [and talents] gravitate towards employment in the creative industries – a phenomenon termed "embedded IS labour" in this study (Bridgstock, 2011).

The researcher could not find enough data to comment on the speed and magnitude of these employment trends in South Africa (further research opportunity discussed later), but included creative industry employment readiness in the IS Graduate Development Framework to emphasise the importance of IS students understanding how their future workplaces are changing – expanding – to include several professional occupations traditionally linked to a study of business and the arts.

Mentioned earlier in this chapter were technology-community and technology-business conversations that matter. One of these conversations that the researcher suggests for coverage in IS skills development classrooms is the specific policy challenges and technology needs expressed by the creative industries (Flew, 2011).

8.1.6 IS education

At the heart of this study's contribution are tailor-made IS courses that target and fill scarce skills gaps in the short term, and educators adjusting longer term degree course content accordingly (as fast as is institutionally possible).

As a fundamental shared concern, IS departments should *all* aim towards producing a larger number of high-quality, industry-ready graduates. This relates to running focussed IS courses at all levels of the labour supply chain – at secondary school, diploma level, degree level, and postgraduate level. These courses should be long enough to facilitate the establishment of long-term relationships that can be used to motivate and inform career choices, but short enough to catch up to and stay attuned with industry demands. As discussed in section 8.1, IS courses should be flexible, adapting to changes in industry demand. Scarce skills courses should take the form of short transition and reskilling programmes, allowing a window period for longer-term syllabus changes to be pushed through.

In the next section the researcher confirms that the research results and contribution – the IS Graduate Development Framework supporting mobile application, and the discussion thereof – have indeed answered the research question of this study.

8.2 Answering the research question

At the outset of this research study, the researcher defined the research question as follows.

How can the quality and quantity of tertiary enrolments and graduates in IS [and IS-related] studies be increased?

The reason for asking this research question was the researcher's understanding [assumption] that an increase in the quality and quantity of IS enrolments and graduates would address the IS skills deficiency in South Africa. In hindsight, the research question might have been worded differently to indicate this assumption.

The reader is now familiar with the approach followed to answer this research question. The research consisted of four parts, Part 1, 2, 3 and 4, each presented as a results chapter [in article form] of this thesis. Each of these sections investigated a different part of the primary research question, as follows:

- **Part 1:** Why are current ICT infrastructure development and IS education development projects not producing the required results? Can these existing projects be accelerated towards sustainability?

  The researcher answered this sub-question by presenting the reader with an updated maturity model with which to measure development project maturity [and ability to sustainably impact the IS skills shortage], and identified key variables that can be used to stimulate development projects towards sustainability.

- **Part 2:** What is the nature of the current IS graduate supply and demand? Does the human capital approach to labour supply give us any new insights into the existing IS graduate supply shortage? Why are so few students (and so few good students) choosing IS or IT as study field or career choice (hence choosing to become part of the IS graduate supply chain)?

  The researcher answered this sub-question by producing both (i) a supply and demand model of the South African IS labour market, and (ii) a regression model that identified key variables for influencing the nature of IS labour supply. Variables that influence the study and career choices of students (towards or away from IS) are included in the regression model. The supply and demand model and the regression model that include education-based variables together present a new, insightful view of what IS educators need to do to

address the IS skills shortage. These findings can be categorised as forming part of the human capacity-building debate.

- **Part 3:** Can short IS transition and reskilling courses be implemented as sustainable projects that will assist a typical IS department in increasing the quality and quantity of first-year enrolments and the quantity and employability of final-year graduates? Were these projects successful?

  The researcher answered this sub-question by implementing two courses, one short transition course and one reskilling course. The success of these projects in increasing the quality and quantity of potential enrolments and the employability of graduates, as discussed in Part 3, indicated that this type of project could be an education-based solution (as opposed to an infrastructure-based solution) to the IS skills shortage. The researcher also presented a more nuanced answer to the issue of project sustainability (the focus of Part 1) in this section. The two courses, both of which survived donor funding withdrawal and institutional barriers, managed to become sustainable within a year as a result of the application of the findings in Part 1 and Part 2.

- **Part 4:** Can the research findings of this study be combined into a framework that will assist IS departments in increasing the quality and quantity of their enrolments and graduates, thus answering the primary research question of this study?

  The researcher answered this sub-question by constructing the IS Graduate Development Framework from the results of Part 1, 2 and 3. The researcher tested the framework for relevance, and found it to describe IS graduate development projects accurately, making useful suggestions to IS departments regarding how and where their supply chain focus could be improved. To assist IS departments with a practical example of how the ISGDF's suggestions might be implemented, a mobile application was developed (by the researcher) that improved the education delivery in the transition course described in Part 3.

This concluding chapter has contributed to answering the research question by placing the IS Graduate Development Framework within the context of the e-skills shortage debate. The ISGDF assists IS departments not only with increasing the quality and quantity of IS enrolments and graduates, but also with focusing the attention of students, their motivators and industry partners on how freedoms within the local community can be increased with the application of newly developed knowledge/skills.

The researcher answers the primary research question of this study as follows. The quality and quantity of IS enrolments and graduates can be increased through IS courses that focus on scarce skills gaps across the IS labour supply chain. These IS courses should adhere to the suggestions made within the IS Graduate Development Framework. Moreover, the researcher now understands that IS graduate development actions should not only focus on addressing the IS skills deficiency [filling skills gaps], but also on preparing and guiding students towards applying their new [scarce] IS skills to local community and business needs. It is through the socially sensitive application of newly developed IS skills that (i) e-skilling programmes will become socially embedded and sustainable (Part 1), (ii) the nature and perceptions of IS labour will change, increasing the price elasticity of IS labour supply (Part 2), and more young learners will be inspired towards a career in IS (Part 3).

The researcher learned, through presenting and critiquing various scarce skills short courses, how to match graduate students with industry and community needs [trends] in a timeous way. The task of educators is not only to teach technical skills that might fill scarce skills gaps, but to increase the employability and community impact of these students as much as possible through industry readiness training – increasing their entrepreneurial and innovation potential in scarce skills areas, and teaching them how to apply these skills to conversations that matter.

8.3 Limitations of this study

Conceptually this study depends quite heavily on the definitions of Sen (1999, 2009). During the review process of the research article presented in Part 1, one reviewer indicated that Sen's theories, as any other, are based on underlying assumptions that are not beyond critique. A critique of Sen's works is beyond the scope of this study, yet the researcher informed this study with recent IS literature that approaches Sen critically (Andersson *et al*., 2012).

This study did not include the salary expectations of students as a variable when measuring the likelihood of students choosing to study IS [or IS-related degrees]. The inclusion of salary expectations as a variable in the regression model designed in Part 2 might provide valuable insights into the nature of IS labour supply (different levels of experience and at different salary rates).

8.4 Future research

The ISGDF suggests the strengthening of relationships between IS education projects, industry stakeholders, government, and local communities. The projects used as case studies in this thesis were designed (and later redesigned) to facilitate these relationships. Several practical policy concerns arose as a result of these relationship-building efforts. The roles of the e-Skills Institute, the e-Skills Hubs (also referred to as CoLabs), and industry partners has not been defined clearly enough in order for local companies to join in e-skilling initiatives. Several companies have indicated a willingness to join forces with the e-SI in e-skilling the nation before 2030 (NPC, 2012). Due to a lack of policy, and a general sense of uncertainty about relationships within the e-skills landscape, several of these companies are reverting to a stand-alone (silo) approach, attempting to develop e-skills with private training/development projects. The effects of this mentioned lack of policy validates urgent further research focussed on standardising relational agreements in the e-skills landscape.

Another (continually resurfacing) concern within the South African skills shortage debate is the lack of a standardised ICT occupation taxonomy. Stakeholders need one consolidated list of occupations and skills to be developed by 2030. Such a list will facilitate accurate measurement of skills shortages. Lotriet *et al*. (2010), Calitz *et al*. (2010) and Cremer (2011) urgently requested further research on the size and nature of the e-skills shortage in South Africa. Such activities must be preceded by an understanding of exactly what should be measured, in the form of a standardised occupation/skills taxonomy. Only if such a taxonomy exists [and is agreed upon by stakeholders] can a meaningful large-scale measuring initiative be completed successfully. Questions such as “what percentage of IS graduates follow careers inside/outside the core technical industries?” can then be answered.

Throughout the duration of this study, the researcher was continually made aware of the importance of stimulating entrepreneurial potential within rural and semi-urban communities. Initial thoughts regarding this avenue of research include the understanding that more than infrastructure or pure IS education will be needed to grow entrepreneurs. The design of such a research study will not be easy, but several lessons can be learnt from the design and implementation of this thesis. Learners’ [and students’] responses to a creative learning environment – such as the mobile application development environments created for the purposes of this study – can be measured, and translated into variables for the early identification of entrepreneurial potential or innovative thought processes. The researcher lists this topic as a possible avenue for future research because of an observed [not measured] spark of innovation or entrepreneurial brilliance in a small percentage

of young individuals when tasked with a highly technical challenge such as time-pressured mobile application development.

The role of the media in ICT-enabled development and IS graduate development requires further research. As mentioned in the introductory chapter of this study, the researcher is interested in the role of social recognition, social celebration, and media (printed and popular) on the success of ICT development projects.

The researcher also suggests further application and refinement of the ISGD framework. This framework has proven itself to be useful in two IS departments by raising informed questions regarding the relevance and development potential of courses [or short-term development projects].

8.5 In conclusion

The researcher's approach to graduate development became more nuanced, more thoughtful [careful] as he progressed through the four parts of this study. The researcher learned about the social nature of development and how neither infrastructure nor education could be forcefully embedded in social structures. He learned how to assist communities and groups of students in taking control of their own development. He found that the nature of the technical skills shortages in South Africa suggests economic growth rather than economic deterioration, and education-based solutions rather than infrastructure-based solutions. These were reassuring findings, but also served as further motivation to delve deeper into the nature of IS graduate supply.

The researcher learned from several thousands of students how far we, as IS educators, would be allowed to influence prospective students to become part of the IS labour supply chain, and by which means. He saw entrepreneurial ideas born as students combined creativity and technology in socially integrated transition and reskilling lectures that brought industry, students and the community closer together.

The researcher presented and tested a graduate development framework that informed the IS labour supply chain with suggestions for counteracting the growth of the IS skills shortage in South Africa. The framework was deemed to give an accurate account of development projects [courses] and their flaws. From the framework's application he learned how to increase the graduate development potential of IS departments. It was not only the framework, or its accompanying mobile application, that made up the whole of the contribution of this study to the IS body of knowledge. The lessons that were learned along the way – teaching a carefully weighed, socially

sensitive, freedom-increasing approach to ICT enabled development – contributed as much, if not more, to the understanding of the challenges surrounding IS employment in South Africa. The development outputs – the increases in freedoms – resulting from this study, by which the study's success will be measured, are dependent on the active application of this informed development approach through the use of the IS Graduate Development Framework to increase the quality and quantity of IS enrolments and graduates, and to guide participating students towards the sensitive application of their IS skills to urgent community and business problems in South Africa.

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APPENDIX 1

- A summary sheet of the data gathered for Part 1 case study – Computer Redistribution Project.

  Sheet split over three pages:

CRP summary of interview data, within extended Five Stages Maturity Model

	Vision	Infra structure	Organisation and rules				Support, trust,		
	Total 1 / 2	Total 1 / 2	General	Ability to handle change	Total 1	Total2	General	Social Embeddedness (Avgerou)	Perceived level of disruption (Avgerou)
S1	4.50	5.50	3.33	2.00	3.33	3.23	3.00	3.00	3.00
S2	7.00	6.00	5.33	2.00	5.33	5.23	5.50	4.00	8.00
S3	6.00	4.50	4.67	2.00	4.67	3.87	5.00	5.00	7.00
S4	3.50	4.00	2.67	2.00	2.67	2.47	3.50	4.00	2.00

VISION
School's initial acceptance of project concept and willingness to participate
Headmaster's vision for project and partnering with university
INFRASTRUCTURE
Sufficient number of working PC's ready for CAT exam use
Internet / general PC access for non-CAT learners at school
ORGANIZATION AND RULES
General
Level of organised access (during and after school) to PCs
Rules that prohibit learners from using PCs at school, during or after hours (1 = highly prohibited, 9 = free access)
Rules/organization that support the functioning of the CRP project
Ability to manage change
Rules/social structure/org that increases ability to handle change in project/environment
SOCIAL RELATIONSHIP WITH PROJECT, SUPPORT AND TRUST
General
Support from community members (incl. teachers, parents) for project
Trust from community members and learners for project
Other categories
Level of social embeddedness (epistemologically) of project concept
Perceived level of disruption / change caused by project (1=highly disruptive, 9 = no disruption)
Level of acceptance of perceived benefit and disruption caused by project
Acknowledgement of potential benefit
Level of local ownership (of needed resources, motivation, and other) of CRP
APPLICATION, USE, AND THE INCREASE OF FREEDOM
General
How frequently are CRP PCs used?
How frequently are technical problems identified in CRP PCs?
Used for homework/academics?
Direct increase in freedom(s)
Better marks/quality of homework/access to information/exam prep due to CRP PCs?
Improvement in university/college enrollment potential

community's relationship with project (Avgerou)					Application and use, measurable increases in freed			
Level of acceptance (Avgerou)	Acknowledgement of potential benefits (Avgerou)	Local Ownership	Total1	Total2	General	Increase in directly targeted freedom (Sen)	Difussed increase in freedom (Sen)	Total 1
3.00	1.00	1.00	3.00	2.40	2.00	3.00	2.00	2.00
6.00	6.00	5.00	5.50	5.65	6.00	5.00	6.00	6.00
3.00	5.00	6.00	5.00	5.30	3.00	5.00	7.00	3.00
1.00	2.00	2.00	3.50	2.65	4.00	2.00	3.00	4.00

	CRP Cape Town			CRP Pretoria			Weights 1
	S1	S2		S3	S4		
	4.50	**7.00**		**6.00**	**3.50**		**0.1576**
	5.00	7.00		8.00	6.00		
	4.00	7.00		4.00	1.00		
	5.50	**6.00**		**4.50**	**4.00**		**0.1475**
	8.00	8.00		4.00	3.00		
	3.00	4.00		5.00	5.00		
	3.23	**5.23**		**3.87**	**2.47**		**0.1472**
	3.33	**5.33**		**4.67**	**2.67**		
	3.00	6.00		7.00	4.00		
	2.00	6.00		2.00	2.00		
	5.00	4.00		5.00	2.00		
	3.00	**5.00**		**2.00**	**2.00**		
	3.00	5.00		2.00	2.00		
	2.40	**5.65**		**5.30**	**2.65**		**0.1585**
	3.00	**5.50**		**5.00**	**3.50**		
	3.00	5.00		5.00	2.00		
	3.00	6.00		5.00	5.00		
	3.00	4.00		5.00	4.00		
	3.00	8.00		7.00	2.00		
	3.00	6.00		3.00	1.00		
	1.00	6.00		5.00	2.00		
	1.00	5.00		6.00	2.00		
	2.30	**5.70**		**4.80**	**3.10**		**0.39**
	2.00	**6.00**		**3.00**	**4.00**		
	2.00	6.00		3.00	4.00		
	2.00	6.00		3.00	4.00		
	2.00	6.00		3.00	4.00		
	3.00	**5.00**		**5.00**	**2.00**		
	3.00	5.00		5.00	2.00		
	3.00	5.00		5.00	2.00		

om (Sen)	Level of celebration and social recognition	Total 1	Total 2	Maturity level Weighted 1	Maturity level Weighted 2
Total2	Total2				
2.30	3.00	32.67	32.33	2.13	2.12
5.70	8.00	59.85	61.96	3.49	3.60
4.80	7.00	42.59	52.07	2.63	3.10
3.10	2.00	36.49	29.64	2.32	1.99

Weights 2

0.13396

Headmaster interviews

0.125375

IT lab project as diffused increase in freedom

0.12512

IT lab project and IT prefects

0.134725

Teacher interviews

Headmaster interview
Students assigned resporsibility

0.3315

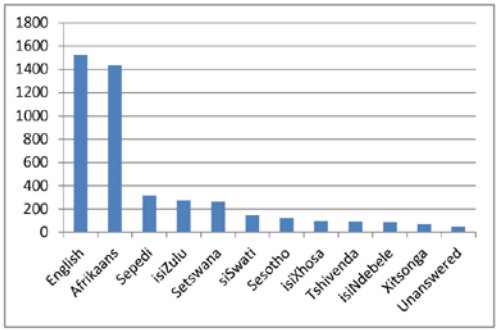
APPENDIX 2

Supporting files for Part 2:

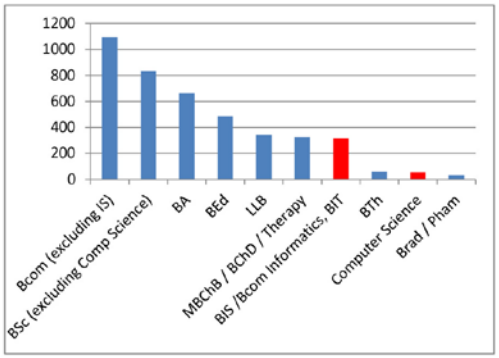
- Questionnaire
- Summary of Questionnaire results
- Results from regression analysis of model

	Online Questionnaire (Part 2)							
	QUESTIONS	**POSSIBLE ANSWERS**						
1	First Language/Home language	English	Afrikaans	Zulu	Xhosa Setswana	Sesotho siSwati	Ndebele Tshivenda	
2	High School Attended	Name of school:						
3	What degree are you currently studying towards?	Name of degree:						
4	What/who was the biggest motivation for your current choice of study?	(1) Parent, (2) Teacher, (3) Role model, (4) Friend, (5) Family member, (6) Life experience, (7) Personal Interest, (8) Aptitude						
5	If you could choose your two favourite/best careers, what would they be?	Career1:	Career2:					
6	Do you have access to a computer at home? Internet?	Computer:	YES/NO	Internet:	YES/NO			
7	Did you have access to computers at your high school? Internet?	Computer:	YES/NO	Internet:	YES/NO			
8	Did you study CAT (Computer Appilcation Technology) or IT (Information Technology) as a subject at high school?	YES/NO	If YES:	Indicate CAT or Computer Science				
9	How important do you think computers are in the work that you are doing/going to do one day?	Likert scale:	1= not important at all		9= critically important (cannot do job without computer)			
10	Have you ever considered a career in IT/technology/e-business?	Likert scale:	1=never ever		9=yes, this is one of my first career choices!			
11	In one sentence, what do you think does a career in Information Systems entail?							

Language	
English	1524
Afrikaans	1436
Sepedi	315
isiZulu	275
Setswana	263
siSwati	146
Sesotho	123
isiXhosa	98
Tshivenda	90
isiNdebele	86
Xitsonga	71
Unanswered	48
	4475



Studying	
Bcom (excluding IS)	1094
BSc (excluding Comp Science)	833
BA	661
BEd	487
LLB	343
MBChB / BChD / Therapy	325
BIS /Bcom Informatics, BIT	316
BTh	59
Computer Science	55
Brad / Pham	33
Other fields of study (< 50)	257
	4463

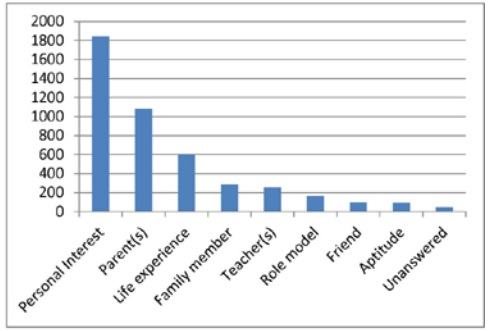


Importance of computer in your job	
Critically important	1820
Important	1916
Somewhat important	518
Not important at all	37

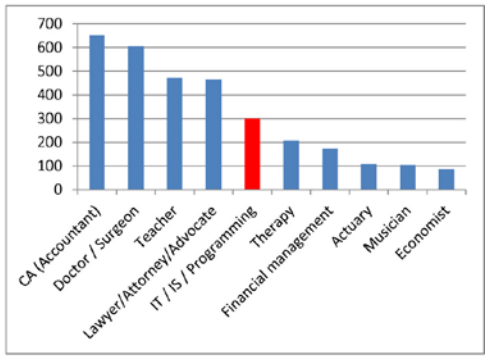
Considered a career in IT/IS	
Strong Yes	102
Yes	122
Weak Yes	841
Very Weak Yes	570
Weak No	359
Strong No	2411
	4405

Understanding of IS as career choice

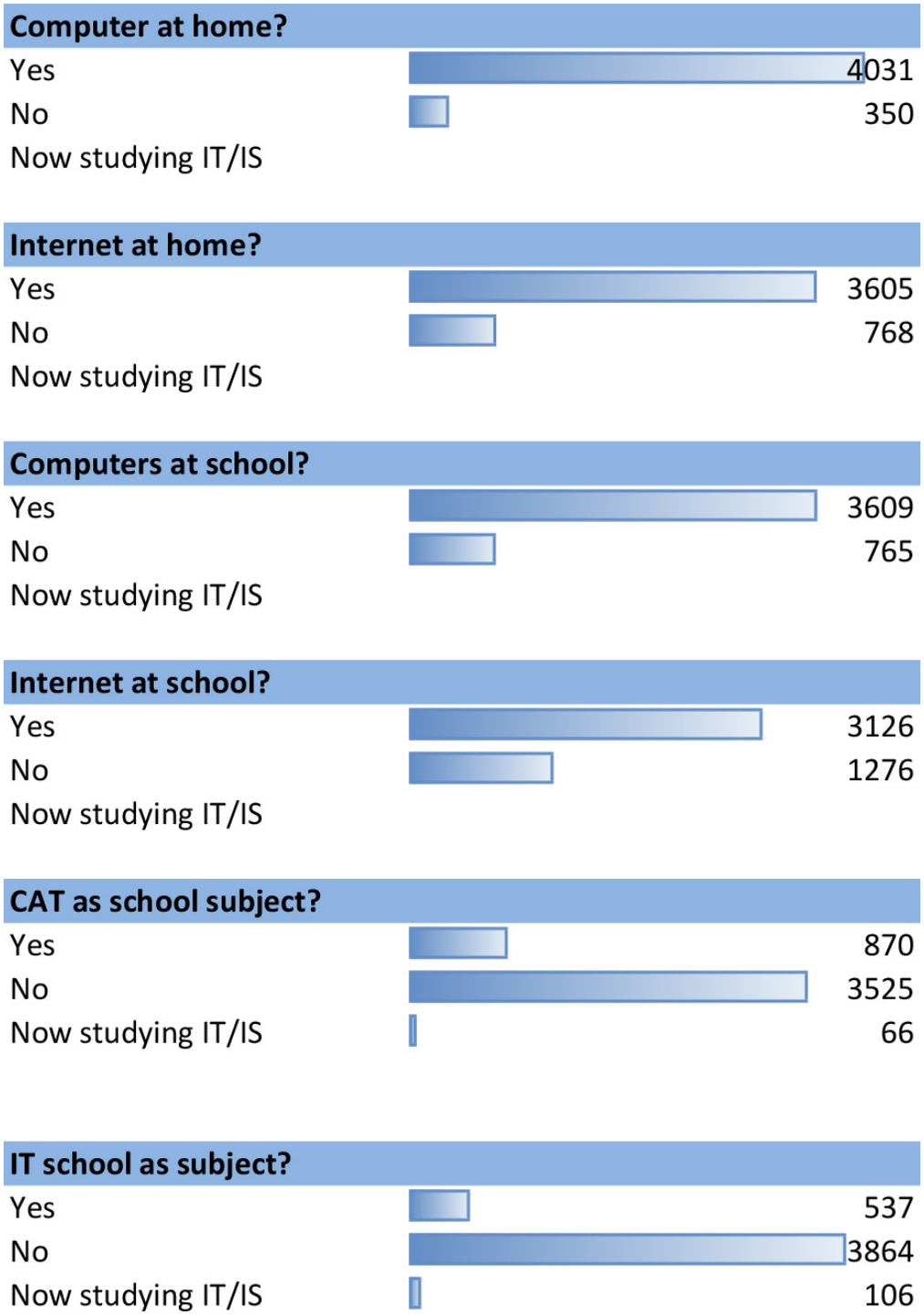
Primary Motivation for choice of study	
Personal Interest	1845
Parent(s)	1083
Life experience	598
Family member	288
Teacher(s)	257
Role model	164
Friend	98
Aptitude	93
Unanswered	49
	4475
Personal Interest + Parent or Teacher	367



Career preferences	
CA (Accountant)	653
Doctor / Surgeon	605
Teacher	472
Lawyer/Attorney/Advocate	464
IT / IS / Programming	301
Therapy	207
Financial management	174
Actuary	108
Musician	105
Economist	88
Business Analyst	11



Study IT/IS/CompSci AND indicated it as a career preference	143
Do not study IT/IS/CompSci and indicated it as a career preference	91


Computer at home?
Yes 4031
No 350
Now studying IT/IS
Internet at home?
Yes 3605
No 768
Now studying IT/IS
Computers at school?
Yes 3609
No 765
Now studying IT/IS
Internet at school?
Yes 3126
No 1276
Now studying IT/IS
CAT as school subject?
Yes 870
No 3525
Now studying IT/IS 66
IT school as subject?
Yes 537
No 3864
Now studying IT/IS 106

Output from R (statistical analysis software):

lm(formula = Y ~ x1 + x2 + x3 + x5 + x6 + x7 + x9 + x10)

Residuals:

Min	1Q	Median	3Q	Max
-0.17565	-0.10512	-0.05017	-0.03748	0.97960

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.085808	0.015974	5.372	8.2e-08	***
x1	-0.023980	0.014169	-1.692	0.0906	.
x2	0.084720	0.008612	9.838	< 2e-16	***
x3	-0.003947	0.017519	-0.225	0.8218	
x5	0.016781	0.008100	2.072	0.0384	*
x6	-0.020729	0.010856	-1.910	0.0563	.
x7	-0.011659	0.010638	-1.096	0.2732	
x9	-0.015938	0.013995	-1.139	0.2548	
x10	-0.033017	0.016361	-2.018	0.0436	*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2516 on 4465 degrees of freedom
F-statistic: 13.52 on 8 and 4465 DF, p-value: < 2.2e-16

APPENDIX 3

Data files for Part 3, including all course related content

- MAD 2012/2013 Project outline document
- Invitations for MAD 2012 / 2013
- Applications for MAD 2012
- Hand-in form (questionnaire) for MAD 2012
- Slideshow – Prize giving MAD 2012

UNIVERSITY OF PRETORIA

Mobile Application Development Project Charter and Course Outline

prepared for the Department of Informatics

by Johan Breytenbach, 10612506

1/3/2012

With this document the Department of Informatics introduces the conceptual plan for the BlackBerry Mobile Application Development Challenge. This project forms part of the Department's commitment towards the National e-Skills Hubs initiative, and functions as an important part of the Department's marketing activities for 2012/2013.

Introduction

With this document the Department of Informatics introduces the conceptual plan for the **BlackBerry Mobile Application Development Challenge**. This project forms part of the Department's commitment towards the National e-Skills Hubs initiative, and functions as an important part of the Department's marketing activities for 2012/2013.

Brief description of project

The project will make use of the Department's newly acquired equipment for mobile application development. The 2012 competition will focus on application development for BlackBerry handsets. The project will be structured as a competition/challenge advertised to promising [and academically qualifying] high school students at UP feeder schools. All high school students [up to a maximum of 40] participating in this project will receive training in mobile application development over a period of six weeks [starting in April 2012], and then have another six weeks in which to create their own BlackBerry mobile application.

Purpose

The purpose of this project is threefold. First, it addresses the skills shortage in the mobile application development industry in South Africa. Second, the project serves as a focussed marketing initiative by the Department of Informatics. It will introduce promising students from UP feeder schools to UP's facilities and facilitate the building of relationships between the Department and these students that will hopefully translate into these top students joining the Department as first year students in 2013. Third, the project participants will be measured according to predefined outputs, including their interest in Informatics/IT as a study choice, throughout the duration of the project. This information may be used to inform academic research within the Department.

Audience/Participants

The competition will be open to any grade 12 high school student at the chosen UP feeder schools that will qualify for tertiary study in a technical field (Mathematics mark > 65%). IT (Java knowledge) as a grade 12 subject will be advantageous, but will not be a requirement for participation.

Resources

Participating students will have regular access to the Department's Mobile Application Development facilities over the scheduled 12 week duration of this project. The lab manager and pre-assigned assistants will provide training during the first six weeks, and serve as contact points/mentors for the final six weeks.

This project will serve as an opportunity for all Academic Staff in the Department to build relationships with promising prospective students, shape and build the IS/IT interests of these students, and learn how to develop mobile applications themselves.

Research value

The success of this project in (1) delivering high quality mobile applications, (2) competent mobile application developers, and (3) inspiring young students towards a career/study in IS/IT will be measured and used as research inputs by the Department. The outcomes of this project will also inform the Department's involvement in the DoE's e-Skills Hubs initiative.

Project Outline

A short course outline is provided to serve as a guideline for the theory to be covered during the initial six to seven weeks of training.

SCHEDULE	THEORY	PRACTICAL
Week 1 Introduction (A1)	Introduction to BB App Dev Challenge! Introduction to BB App Dev using **Java** language and tools; Installing and setting up all the necessary tools for BB App Dev	**Install:** Sun JDK, Eclipse SDK, BlackBerry JDE Plug-in for Eclipse, BlackBerry JDE Component Packs 4.3 – 4.7 (A1)
Week 2 First Application (A10)	How to setup and configure new BlackBerry project, How to create classes, Some details about UiApplication and MainScreen, How to write a Hello World application and How to run your application in simulator.	Hello World Tutorial (A10)
Week 3 Signing (A60) User Interfaces (A11)	How and when to sign User interfaces: Title, Managers, Bitmaps, Edit and Label fields, Menu Items, Buttons	Signing Tutorial (A60) User Interface Tutorial (A11)

Week 4 Localizing (A12) Storing Persistent Data (A13)	How to localize your application: creating resource files and the StoreInfo class How to store and retrieve data on the device	Localizing Tutorial (A12) Persistent Data Tutorial (A13)
Week 5 Recap / Consolidation Audio and Video playback (C10)	Make sure tutorials A60, A10, A11, A12, and A13 are completed – Q&A session How to incorporate Audio and Video into your application	A&V Tutorial C10
Week 6 MIDLets and RIMLets (C40) Network Transports (A14)	Using special BB (BB specific) features and functions through RIMLets. How to connect to intranet or internet and send/receive information	Tutorial C40 Tutorial A14
Week 7 (practical) Debug and optimize your App (A50) Distributing your application (A70)	Debugging tools, Garbage collection, memory leaks, deadlocks, simulations All the different distribution channels discussed	Tutorial A50 Tutorial A70
Week 8 (practical) Hand in final concept/application idea and description		
Week 9 – 12 (practical) Develop final application, regular simulations in UP lab		

Invitation to schools

the doc
Department:
Communications
REPUBLIC OF SOUTH AFRICA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Mobile Application Development (MAD) Challenge 2012

Entry form

Hi there! You have been nominated to maybe (just maybe!) be part of the amazing MAD Challenge 2012, hosted by the University of Pretoria and Blackberry (Research in Motion). Please complete this entry form, and submit to:

Every year we can only take 20 – 30 students on this MAD journey, so don't get your hopes up too high :-/ … and hey, if you don't get selected this year, be sure to enter again in 2013 (you will be invited using the email address you give us below)!

Name and surname of student						
Preferred home language						
Name of school						
Mobile phone number						
Email address						
Do you take CAT as high school subject?	YES		NO		Mark(%)?	
Do you take IT as high school subject?	YES		NO		Mark(%)?	
Do you take Mathematics as high school subject?	YES		NO		Mark(%)?	

Do you have any Java programming experience?	YES		NO		I know Delphi		
Have you ever considered studying IT/IS/Computer Science?	Many times		Maybe once		Never!		
In one sentence, what do you think a career in Information Systems entails?							
Would you like more information about IT/IS/Computer Science jobs?							
Who/what **will help you most** to decide what you want to study/do one day? (You may write **1** next to your first choice, **2** next to you second choice, etc.)	Parent(s)						
	Teacher(s)						
	Role model/hero						
	Life experience						
	Personal interest						
	Other						
What is your **two dream jobs** (if you could study anything anywhere?)							
What mobile phone are you currently using (if any)?							
General knowledge question: What is the nickname for Android 4 software?							

Signature student:…….. Signature parent/guardian:……..

Extract from list of applications for MAD 2012

Spreadsheet split over two pages:

1	Name and Surname	Lang	School	Grade	Mobile	Email	CAT	IT	Maths	Java	Delphi	IS Study?
2	Robert Focke	E	Pretoria Boys High	10	0798535404	robert_focke@yahoo.com		89	82	N	Y	2
3	Llewellyn Strydom	A	Pretoria Boys High	10	0721440417	llewellyn121@gmail.com		95	88	N	Y	2
4	Walter Smuts	E	Pretoria Boys High	10	0716105952	wallie1996@gmail.com		82	85	N	Y	2
5	Trystan Rivers	E	Pretoria Boys High	10	0828279756	trystan.b@hotmail.com		87	46	N	Y	2
6	Romeo Drabile	E	Pretoria Boys High	10	0836558070	romeodrabile@gmail.com		76	66	N	N	2
7	Sabelo Memela	Z	Pretoria Boys High	10	0763370749	sabelomemela@gmail.com		77	80	N	N	2
8	Kuda Maneta	E	Pretoria Boys High	10	0715951760	kudamaneta@mobileemail.vc		85	99	N	N	2
9	André du Toit	A	Afrikaanse Hoër Seunss	10	0711271677	andre.christiaan.dutoit@hotm		83	81	N	N	2
10	Eben du Toit	A	Afrikaanse Hoër Seunss	10	0762992363	eben4ammo@gmail.com		91	74	Y	N	2
11	Hendrik Steenberg	A	Afrikaanse Hoër Seunss	10	0825722530	hen3.2580@gmail.com		82	65	N	Y	2
12	Jacobus Fourie	A	Afrikaanse Hoër Seunss	10	0718777857	jhdevill@gmail.com		97	74	N	Y	2
13	Kenneth Holder	A	Afrikaanse Hoër Seunss	10	0715176420	kennethholder@yahoo.com		76	68	N	Y	2
14	Pedrie Oosthuizen	A	Afrikaanse Hoër Seunss	10	0723782695	janmagda@vodamail.co.za		85	95	N	Y	2
15	Arend Stoffberg	A	Afrikaanse Hoër Seunss	10	0796464439	arend.stoffberg@gmail.com		89	92	N	Y	2
16	Enoch Lottering	A	Afrikaanse Hoër Seunss	10	0825543873	enoch.lottering@gmail.com		66	88	N	Y	1
17	Divan van Heerden	A	Afrikaanse Hoër Seunss	10	0725660515	divanvh@hotmail.com		80	94	N	Y	2
18	SD Steyn	A	Afrikaanse Hoër Seunss	10	0795079407	sd.steyn@gmail.com		78	80	N	Y	2
19	Jacques de Beer	A	Afrikaanse Hoër Seunss	10	0839980860	jacquesadebeer@gmail.com		70	84	N	Y	1
20	Reynard Droste	A	Afrikaanse Hoër Seunss	10	0794827640	reydros@gmail.com		84	69	Y	N	2
21	Olebogeng Molefe	E	Hoërskool Gerrit Maritz	10	0786974276	olebomolefe@webmail.co.za		61	74	N	N	1
22	Brennan Buitendag	E	Hoërskool Gerrit Maritz	10	0827090916	brennanbuitenbdag@gmail.co		84	94	N	N	2
23	Eben Schuttle	A	Hoërskool Die Wilgers	10	0832727321			60	70	N	Y	2
24	Marco Vledder	A	Hoërskool Die Wilgers	10	0792772324	marcovledder4@gmail.com		69	63	Y	Y	2
25	Riaan de Winnaar	A	Hoërskool Die Wilgers	10	0788048190	sales@irp.co.za		52	49	N	N	2
26	Nicola Wolfaardt	A	Hoërskool Die Wilgers	10	0823464779	nicola.wolfaardt@gmail.com		94	95	N	N	2
27	Shaun Janse van Vuuren	A	Hoërskool Die Wilgers	10	0748282786	emalan@basilread.co.za		63	40	N	N	2
28	Annerie van Jaarsveld	A	Hoërskool Die Wilgers	10	0832291257	albie@nes.co.za		N	83	N	N	1
29	Brendon van der Meijden	E	The Glen High School	10	0828131735	brendonvandermeijden@gma		Y	57	N	Y	2
30	Mpho Monadime	E	Hoërskool Silverton	10	0844453016	coj4eva@gmail.com	75	N	83	N	N	1
31	Hlakani Petros	E	Hoërskool Silverton	10	0727141754	hlaxpetros@gmail.com	65	N	53	N	N	1
32	Nicole Makhambeni	E	Hoërskool Silverton	10	0781715054	makhambeniiicole@gma	76	N	54	Y	N	2
33	Lesego Msita	E	Hoërskool Silverton	10	0732008284				72	Y	Y	2
34	Lesiba Khalo	E	Hoërskool Silverton	10	0834770989	lesibakhalo16@gmail.co	52		68	N	N	2
35	Princess Mahlangu	E	Hoërskool Silverton	10	0761578615	mahlanguprincess778@	69		60	Y	N	1
36	Sam Matsemela	Sep	Eersterust Sekondêr	10	0827006029	msamiza@gmail.com			Y	N	N	0
37	Martin Khanye	E	Eersterust Sekondêr	10	0715991787	martin_khanye@yahoo.com				Y	N	1
38	Delvin Klaasen	E	Eersterust Sekondêr	10	0742543417	delvin.klaasen@ovi.com			79	N	N	2
39	Reuben Mohlala	E	Eersterust Sekondêr	10	0762278102	reuben.moshe@live.com			69	Y	Y	1
40	Sarah Moloto	E	Eersterust Sekondêr	10	0781424766	molotojuju@gmail.com	64		Y	N	N	2
41	Nigel Nsingo	Seso	Eersterust Sekondêr	10	0719667258	nigelnsingo@yahoo.con	70		76	Y	N	1
42	Nifa Amidu	E	Eersterust Sekondêr	10	0820671489	anifam@ovi.com			78	N	N	1
43	Demondre Williams	E	Eersterust Sekondêr	10	0748620026	demondewilliams55@gn	75		58	Y	N	1
44	Kayla	E	Eersterust Sekondêr	10	0743822745				50	N	N	1
45	Mabotse Komane	E	Eersterust Sekondêr	10	0745473367		60		Y	N	N	1
46	Shelton Solly	E	Eersterust Sekondêr	10	0728088864	shelton.solly@gmail.cor	65		40	N	N	2
47	Zaideen Damon	E	Eersterust Sekondêr	10	0799574058	zhaideendm@gmail.com	75		50	N	N	2
48	Tyler Hoffman	E	Pretoria Boys High	11	0832842740	tylerhof@hotmail.com		94	97	Y	Y	2
49	David Bradfield	E	Pretoria Boys High	11	0760434054	david.gbradfield@gmail.com		80	80	Y	N	2

Motive1	Motive2	Dream1	Dream2				Consider studying IS	Change
PI	LE	Game Developer	Software Engineer	1	1	1	Yes	0
PI	LE	Software Enginee	Systems Analyst	1	1	1	Yes	0
PI	LE	Aerospace Engin	Helicopter Pilot			1	Yes	1
PI	TE	Pixar Animator	Programmer		1			
PA	LE	Actuarial Science	Medicine			1	Yes	1
PI	LE	Software Enginee	Aviation Engineer	1	1	1	Yes	0
PI	PA	Actuarial Science	Computer Science	1	1	1	Yes	1
PI	LE							
PI	LE	Software Enginee	Electronical Engineer	1	1	1	Yes	0
PI	LE	Aerospace Engin	Programmer		1			
PI	PA	Software Enginee	Software Engineer		1			
LE	PI	Vet	IT Specialist		1			
PI	LE	Software Enginee	Computer Science	1	1	1	Yes	0
PI	LE	Computer Scienc	Bsc IT	1	1	1	Yes	0
PI	PA	Mechanical Engir	Electronical Engineer					
PI	LE	Solutions Archite	Chartered Accountant			1	Yes	0
PI	PA	Actuarial Science	Manager		1	1	Yes	1
PA	LE	Chemical Engine	Chemistry				No	0
PA	PI	Entrepreneur	Programmer		1			
PI	PA	Plastic Surgery	IT Specialist		1			
PA	PI	IT Specialist	Chartered Accountan	1	1	1	Yes	1
PI		Electronical Engi	Accountant				Maybe	0.5
OT	EBIT Wee	IT Specialist	Project Manager	1	1	1	Yes	0
PA	TE	IT Specialist	Animals		1			
PI	LE	Digital Designer	Microbiologist				Yes	0
PI	LE	Software Enginee	Game Developer		1			
LE	PA	Chartered Accou	Doctor			1	Yes	0.5
PI	OT	Game Developer	Game Comp Owner	1	1	1	Yes	0
PI		Evangelist	Accounting / Political Science					
PI	PA	Chemical Engine	Archeology					
PI	PA	Software Enginee	Accountant		1			
PI	LE	Programmer	Accounting		1			
PI	LE	Industrial Enginee	Mining Engineer					
PI	RM	Chartered Accou	Computer Science		1			
PI	LE	Media	Teaching					
LE	PI	Chartered Accou	Pilot					
LE	PI	Medical Doctor	Lawyer					
PI	LE	Medical Doctor	Musician					
PI	LE	Mechanical Engir	Medicine					
LE	PI	Chartered Accou	Engineering					
PI	PA	Biologist	Medicine					
RM	PI	Lawyer	Nurse					
TE	Sister	Nurse	Social Worker					
PI	LE	Lawyer	Mechanical Engineering					
PI	LE	Graphic Designer	IT Specialist		1			
PI	LE	Programmer	Musician	1	1	1	Yes	1
PI	OT	Work at LHC	Astronomer					

University of Pretoria

Department: Informatics

Mobile Application Development (MAD) Challenge 2012

HAND-IN / EVALUATION FORM

Thank you for being part of MAD 2012! Please give us your feedback below:

Name and surname of student						
Name of school						
Mobile phone number						
Email address						
Name of other team members, if any:						
Did you attend the MAD 2012 lectures?	YES		NO		At least 3 times	
Did you hand in an app / complete the course?	YES		NO			
What is the name of your app?						
After being part of this competition, will you consider studying IT/IS/Computer Science?	YES		Maybe		Never!	
Would you like more information about IT/IS/Computer Science/Mobile programming jobs?						
How much (salary) do you think a mobile application developer earns per month?						
Who/what **will help you most** to decide what you want to study/do one day? (You may write **1** next to your first choice, **2** next to you second choice, etc.)	Parent(s)					
	Teacher(s)					
	Role model/hero					
	Life experience					
	Personal interest					
	MAD 2012					
What are your **two dream jobs** (if you could study anything anywhere?) **after being part of MAD 2012**						
Has this course/competition motivated or inspired you (in any way) to learn more about new technologies and creative media? Explain your answer.						
How difficult is it to write a mobile app? **Give a number between 1 and 9.** 1 = super easy, 9 = impossible!!						
Any suggestions for making the course better?						

MAD 2012 – Prize giving 22 November 2012 - Slideshow

MAD Challenge 2012

Results and Prizegiving
22 November 2012

Introduction

- Grade 10, 11 [and a few Grade 12's]
- 60 learners [9 schools] started the Challenge
- 30 finished [6 schools]
- 16 BlackBerry Apps

MAD Challenge 2012

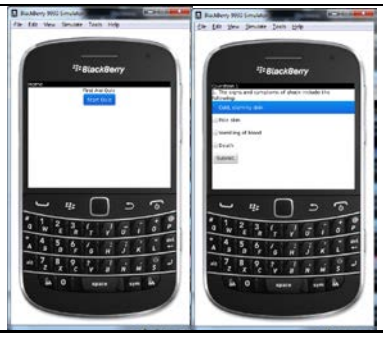
The Applications

First Aid Quiz (FAQ)

Group 1
Nicola Wolfaardt
Annerie van Jaarsveld
Hoerskool Die Wilgers

Description

"We decided to create an application that can help you to learn for a first aid exam. The application would be a quiz with questions from a first aid manual. The questions will be for a level one First Aid certificate. ***More difficult questions and more quizzes can be bought by the user at a later stage.***" - Nicole and Annerie



Snakes

Group 2
Arend Stoffberg
Kennith Holder
Afrikaanse Hoër Seunsskool

Description

"Our app allows people to play Snakes. The app is very conveniently accessible through any menu item on the BlackBerry device. The idea of the app is to see how many points you can earn by manoeuvring a snake towards squares and eating them. We will sell our app on BlackBerry app world. People with BlackBerry's can download it for R3. The game is pretty enjoyable and very addictive." - Arend and Kennith

Brain Freezer

Group 3
Abel Sathekge
Banza Ilunga
Pretoria Secondary

Description

"While asking questions it also gives them hints and also teaches them about the question they are being asked, this app also includes a short article about the brain following with questions on the article, also included the app has a browser field that connects to a web site that teaches the user more about the brain" – Abel and Banza

Learners Test App (1)

Group 4
Brendon van der Meijden
The Glen High School

Description

"I am planning to create two versions of this product. Namely a free and pro version.
The free version will only consist of 10 questions… And will remind the user there is a paid for version at the end as well as have 1 quick advert in order to make money from those who only use the free version." - Brendon

Learners Test App (2)

Group 5
Brennan Buitendag
Hoërskool Gerrit Maritz

Description

"Initially a list of valid questions will be selected. These questions will then be complied into a multiple choice test. Three options will be available for the candidate to select. The candidate will be informed as to whether or not the answer is correct. The candidate will not be given the correct answer. At the end of the test the candidate will receive a score out of 100 as well as the percentage. The test can be repeated as many times as the candidate requires." - Brennan

Learners Test App (3)

Group 14
Sabelo Memela
Romeo Drabile
Pretoria Boys High

Die Affie App

Group 6
Divan van Heerden
Jacques de Beer
Afrikaanse Hoër Seunsskool

Description

The boys from Affies ,with their student code, will be able to download the app from the school website. The app will give students access to the latest music, videos and images as well as work files for each subject in each grade that the teachers have uploaded on the web server.(The app will connect to our webservice to enable the downloading of these files)

Student Timetable/Register

Group 7
Eben du Toit
Jacobus Fourie
Afrikaanse Hoër Seunsskool

Description

"Our app will use the phone to check you in at a certain location, by using the app at places such as a school or working environment or college. It will state what subject you have to attend and check you in at every class independently. This will be useful because when the app confirms you are present it will send you notes, time tables, home work etc. It will also reduce physical administration for teachers as it is an effective way to keep an attendance register." – Eben and Jacobus

My World

Group 8
Emmanuel Faleye
Nigel Mpofu
Pretoria Secondary

Description

"Combine the student's favourite website links, music and media sites, and education links in one app." Emmanuel and Nigel

BackUP

Group 9
Kuda Maneta
Robert Focke
Pretoria Boys High

Description

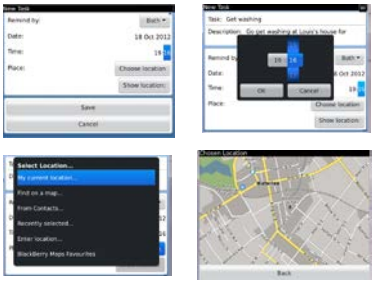
"Our application is very profitable since any money earned is essentially profit since we spent no money making the application. We believe that our application will cater to teenagers (who usually have many blackberry messenger contacts) and business people who use blackberry messenger to communicate with their colleagues and clients. The application could be marketed as a "lite" version which would only backup the blackberry messenger contacts and a "pro" version which would update anything that the user wants (memos, cell phone numbers and applications?). The lite version would be free and the pro version could be sold for a small amount of money." – Robert and Kuda

ToDoList

Group 10
Llewellyn Strydom
Walter Smuts
Pretoria Boys High

Description

"The application we made is a to-do list which, like all to-do lists, has a task with a title and a description. Furthermore it has a couple of ways of reminding the user of the task. The user can set the time and date the app must remind him/her of the task. The aspect which makes this app unique is that it has another way of reminding the user of a task. The user can select either on a map, from their favourites or from their current location an area which will be connected to that task to alert the user of the task when they enter the region." – Llewellyn and Walter



Glonass+ (Global Nav System+)

Group 11
Marco Vledder
Eben Schutte
Hoërskool Die Wilgers

Description

"The purpose of the app is to view Gps data such as youre coordinates and speed etc .The app can also upload your location to the website of your choice. Once you're back at your computer, you can then use the files to geotag photos, aswell as upload to travel sites, view in Google Earth and so on." Eben and Marco

Demo

Capture 01.wmv

Cool Places

Group 12
Matthias Harvey
Ray Kruger
Pretoria Boys High

Description

"It allows you to upload a picture and a short description of a "Cool Place" onto a map that all other users of the app can access. A user looking for a cool place can either do a search for matching places e.g. Cliff diving or can browse the map for nearby ones." – Ray and Matthias

PanicPal

Group 13

Pedrie Oosthuizen

Afrikaanse Hoër Seunsskool

Description

"Once the user clicks on the panic button the app sends a BBM to a contact that is specified by the user - the BBM includes a SOS message as well as the users information and location."

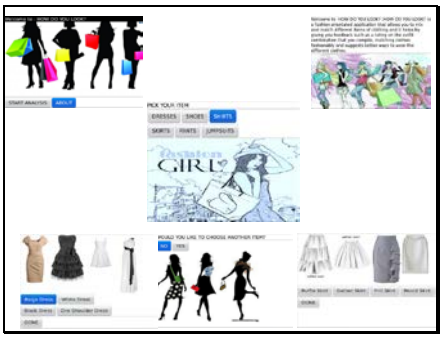
How do you look?

Group 15

Sameya Kabeya

Charity Maropola

The Glen



Description

"Our app is called "How do you look?" and it is basically a fashion orientated application that allows the user to mix and match different items of clothing and it helps the user by giving them feedback such as a rating on the outfit combination that they compile, matching clothes fashionably and suggests better ways to wear the different clothes." - Sameya and Charity

LMG

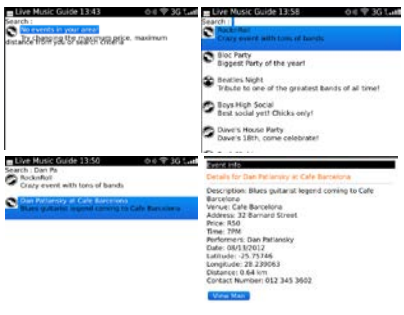
Live Music Guide

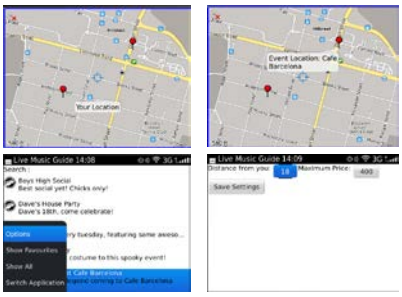
Group 16

Tyler Hoffman

Unathi Chonco

Pretoria Boys High





Description

"Using the location acquired from the user's device, this application will display the live music events within a user specified distance. The events will be displayed in a list and will display more detailed information if selected, with the option to display the location of the event on the map.

The app itself will be a free download for anyone on the app world to download. Income will be generated from bands/groups/venues registering in order to use our app to get information about their events to the users of our app, their potential customers." – Unathi and Tyler

MAD Challenge 2012

The Winners

In 5th place:

Brain Freezer

Group 3
Abel Sathekge
Banza Ilunga
Pretoria Secondary

How do you look?

Group 15
Sameya Kabeya
Charity Maropola
The Glen

In 4th place:

Learners Test (1)

Group 4
Brendon van der Meijden
The Glen High School

First Aid Quiz (FAQ)

Group 1
Nicola Wolfaardt
Annerie van Jaarsveld
Hoerskool Die Wilgers

In 3rd place:

BackUP

Group 9
Kuda Maneta
Robert Focke
Pretoria Boys High

ToDoList

Group 10
Llewellyn Strydom
Walter Smuts
Pretoria Boys High

In 2nd place:

Live Music Guide

Group 16
Tyler Hoffman
Unathi Chonco
Pretoria Boys High

In 1st place:

Learners Test (2)

Group 5
Brennan Buitendag
Hoërskool Gerrit Maritz

APPENDIX 4

IS Graduate Development Framework measures:

	Likert (1-5)			
Question 1	**L1**	**L2**	**L3**	**AVG**
Was diffusion maturity (or a higher level of maturity) reached within budget?				
Observable indirect increases in economic freedoms	4	3	4	3.67
Observable indirect increased in social freedoms	3	4	4	3.67
Was the project within budget when these observations were made?	4	4	4	4.00
	3.6667			3.78
Question 2	**L1**	**L2**	**L3**	**AVG**
Did community members take ownership of the project? Was it socially well-embedded?				
Support from community members (incl. univ, schools, teachers, parents) for project	4	5	5	4.67
Acknowledgement of project benefits and level of acceptance of perceived benefit and disruption caused by project	2	2	3	2.33
Level of local ownership (of needed resources, motivation, and other) of this project	3.5	4	4	3.83
	3.1667			3.61
Question 3	**L1**	**L2**	**L3**	**AVG**
What was the influence of media coverage and social recognition on this project (and participants)?				
Was there any recognition/involvement from high profile community members and/or academia for this project, and what was the level of impact of their involvement on learners?	4	4	4	4.00
Any certificates, prizes, status, or other incentives linked to the celebration of success of learners? What was the level of impact of these incentives on learners/parents?	5	5	5	5.00
Any local media coverage or recognition at schools, universities, or within community groups? The impact of these on learners/teachers/parents?	4	4	4	4.00
	4.3333			4.33

Question 4	L1	L2	L3	AVG
Did any direct, measurable development (increases in freedom) result from project?				
Observable direct increases in economic freedoms	3	2	3	2.67
Observable direct increased in social freedoms	2	3	3	2.67
Was the project within budget when these observations were made?	3.5	4	4	3.83
	2.8333			3.06

Question 5	L1	L2	L3	AVG
Is this project moving forward, accelerating towards sustaibably increasing the quality and/or quantity of students?				
Is there a positive difference between the current maturity level of the project and previous maturity measures? How significant is this growth?	4	4	4	4.00
Measurable increase in graduates, or potential enrolments?	4	3	4	3.67
Measurable increase in the quality (aptitude, employability) of potential graduates, or enrolments	4.5	4	4	4.17
	4.1667			3.94

Question 6	L1	L2	L3	AVG
Does this project/course include a focus on industry readiness?				
Informed by industry needs analysis?	3.5	5	4	4.17
Input from industry stakeholders?	2	3	2	2.33
	2.75			3.25

Question 7	L1	L2	L3	AVG
Does this project/course provide students with sufficient career/industry information?				
Did this course include a measurement of student career knowledge and career motivation towards ICT/IS?	4	4	4	4.00
Were students thoroughly informed about career options related to the course (during or after course)?	2	2	2	2.00
Did this course satisfy the students' and/or parents' information needs regarding potential fields of study?	2	2	2	2.00
	2.6667			2.67

Question 8	L1	L2	L3	AVG
Does this project/course include current scarce skills in subject matter?				
Scarce skills covered at satisfactory level (depends on which part of the supply chain this course is aimed at)?	4	5	4	4.33
Did students manage/master the course content within the given time period?	2	2	3	2.33
Was there sufficient (and aptly trained) staff members available to present this course at the required level?	4	3	4	3.67
	3.3333			3.44

Question 9	L1	L2	L3	AVG
Does this project/institution leverage primary study choice motivators through long term involvement with (prospective) students?				
Does the course structure facilitate long term lecturer relationships with students?	4	4	4	4.00
Does this course leverage the long term relationships of parents and teachers with students to influence career choice variables?	1	1	1	1.00
	2.5			2.50

Question 10	L1	L2	L3	AVG
Does this project result in a dirent increase in ICT labour supply (graduates or enrolments) through education?				
Increase in graduates or enrolments?	4	3	4	3.67
	4			3.67

Question 11	L1	L2	L3	AVG
Does this project result in an increase in ICT labour supply elasticity (variables in Part 2 findings)?				
Does this course increase industry knowledge and inform student perceptions regarding salary expectations to the degree that they can make well informed career decisions?	3	3	3	3.00
Does this course build long term relationships between learners and motivators? Between learners and industry?	2.5	3	3	2.83
Does this course promote IT and CAT as secondary school subjects?	2	3	2	2.33
	2.5			2.72

Question 12	L1	L2	L3	AVG
Does this project/course structure allow for realisation based comparison approach to filling identified ICT skills gaps; ie. Is the project sufficiently non-institutional in nature?				

Does the course/institution structure allow for year-on-year changes to course content and major sylabus changes?	4	4	4	4
Did the course content change towards industry needs during the last year?	3	3	3	3
	3.5			3.5

Question 13	**L1**	**L2**	**L3**	**AVG**
Industry is involved in identifying and filling scarce ICT skills gaps at the targeted level?				
Internships, or similar programs for promising students?	3	3	3	3
Industry actively involved in sylabus setup?	2	2	2	2
	2.5			2.5

Question 14	**L1**	**L2**	**L3**	**AVG**
Is this a short course focused on the transition or reskilling of students towards ICT employment?				
Transition or reskilling course?	5	5	5	5
	5			5

Question 15	**L1**	**L2**	**L3**	**AVG**
Does this course include entrepreneurial/innovation soft skills and examples in course content?				
Entrepreneurial soft skills (networking, industry analysis, presenting ideas, brainstrming sessions, small group collaborations sessions)?	3	2	3	2.666667
Examples of entrepreneurial application of knowledge discussed in class?	2	2	2	2
	2.5			2.333333

Question 16	**L1**	**L2**	**L3**	**AVG**
Project/course/institution has transdisciplinary application focus?				
Does this course focus on applications outside the core ICT industries?	4	5	4	4.333333
Any successful transdisciplinary applications as a result of this course?	3	4	4	3.666667
	3.5			4

Question 17	**L1**	**L2**	**L3**	**AVG**
Project/course/institution develops skills for core ICT industries in scarce skill areas?				

Can the skills that are developed in this course be used during employment in the core ICT industry?	4	5	4	4.333333
	4			4.333333

Question 18	**L1**	**L2**	**L3**	**AVG**
Project/course/institution develops ICT labour to be embedded in creative industries?				
Can the skills that are developed in this course be used during employment in the creative industries?	4.5	4	4	4.166667
	4.5			4.166667

Question 19	**L1**	**L2**	**L3**	**AVG**
Project/course/institution is sensitive to creative industry business/policy challenges?				
Are Creative Industry business models discussed in this course?	2	2	2	2
Are Creative Industry policies, such as copywirte, distribution agents, and industry regulations discussed as part of this course?	1	1	1	1
	1.5			1.5

Question 20	**L1**	**L2**	**L3**	**AVG**
Project/course/institution measurably increase students' employability for core ICT and/or embedded ICT careers?				
Was an increase in employability measured as a result of this course?	4.5	4	5	4.5
	4.5			4.5

APPENDIX 5

ISGDF Mobile Application – Code Segment – Proof of concept

Code segments from mobile application presented in Part 4B:

- RSS Feed Reader in Andriod application, and how it reads feeds from WordPress blog sites
- With functions for parsing GPS coordinates from blog posts, which informs mapview objects within the same application

```
package za.co.myuniversityapps.upmad;

import java.io.IOException;
import java.io.InputStream;
import java.net.MalformedURLException;
import java.net.URL;
import java.util.ArrayList;
import java.util.List;

import za.co.myuniversityapps.upmad.R;

import org.xmlpull.v1.XmlPullParser;
import org.xmlpull.v1.XmlPullParserException;
import org.xmlpull.v1.XmlPullParserFactory;

import android.net.Uri;
import android.os.AsyncTask;
import android.os.Bundle;
import android.os.Handler;
import android.os.Message;
import android.app.Activity;
import android.app.ListActivity;
import android.content.Context;
import android.content.Intent;
import android.util.Log;
import android.view.Menu;
import android.view.View;
import android.widget.ArrayAdapter;
import android.widget.ListView;

public class RssReader extends ListActivity {

        //VARS
        private List<String> headlines;
        List<String> links;
        private List<String> longs;
        private List<String> lats;
        private List<String> addresses;

        //private List<?> images;
        private XmlPullParser xpp;
        private URL url;
        int eventType;
        private Thread t;
        private ArrayAdapter<String> adapter;
        private InputStream is;
        private XmlPullParserFactory factory;

        @Override
        public void onCreate(Bundle savedInstanceState) {
```

```
        //LOAD STATE AND VIEW
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);

        //LOAD RSS FEED
        getRSSFeed();
}

public void getRSSFeed() {
        //Start a seperate thread
        t = new Thread(){
                public void run() {
                        headlines = new ArrayList<String>();
                        links = new ArrayList<String>();
                        longs = new ArrayList<String>();
                        lats = new ArrayList<String>();
                        addresses = new ArrayList<String>();
                        //images = new ArrayList<Object>();

                        //SET URL
                        try {
                                url = new
                        URL("http://ifsuwc.wordpress.com/?feed=rss");

                        } catch (MalformedURLException e3) {
                                // TODO Auto-generated catch block
                                e3.printStackTrace();
                        }

                        //XmlPullParserFactory factory;
                        try {
                                factory = XmlPullParserFactory.newInstance();
                                factory.setNamespaceAware(false);
                                xpp = factory.newPullParser();

                        } catch (Exception e4) {
                                // TODO Auto-generated catch block
                                e4.printStackTrace();
                        }

                        //GET THE XML INPUT

                        try {
                                is = url.openConnection().getInputStream();
                        } catch (Exception e) {
                                Log.d("Thread","connection issue");
                        }

                        try {
                                xpp.setInput(is, "UTF_8");
                        } catch (XmlPullParserException e1) {
                                // TODO Auto-generated catch block
                                e1.printStackTrace();
                        }

                        boolean insideItem = false;
                        try {

                                eventType = xpp.getEventType();
                        } catch (XmlPullParserException e) {
                                // TODO Auto-generated catch block
                                e.printStackTrace();
                        }
```

```
while (eventType != XmlPullParser.END_DOCUMENT) {
	if (eventType == XmlPullParser.START_TAG) {
		if (xpp.getName().equalsIgnoreCase("Item")) {
			insideItem = true;
		} else if
	(xpp.getName().equalsIgnoreCase("title")) {
			if (insideItem) {
				try {
					//get the title of the
					blog post into headlines

				headlines.add(xpp.nextText());
				} catch (XmlPullParserException e) {

					} catch (IOException e) {

					}
				}
		} else if
	(xpp.getName().equalsIgnoreCase("link")) {
			if (insideItem) {
				try {
					//get the link of the
					blog post into links

					links.add(xpp.nextText());
				} catch (XmlPullParserException e) {

					} catch (IOException e) {

					}
				}
		} else if
	(xpp.getName().equalsIgnoreCase("maps_long")) {
			if (insideItem) {
				try {

			longs.add(xpp.nextText());
				} catch (XmlPullParserException e) {

					} catch (IOException e) {

					}
				}
	} else if (xpp.getName().equalsIgnoreCase("maps_lat"))
{
				if (insideItem) {
					try {

			lats.add(xpp.nextText());
				} catch (XmlPullParserException e) {

					} catch (IOException e) {

					}
				}
} else if (xpp.getName().equalsIgnoreCase("maps_address")) {
				if (insideItem) {
					try {
					addresses.add(xpp.nextText());
				} catch (XmlPullParserException e) {
```

```
                                                        } catch (IOException e) {

                                                        }
                                                }
                                        }

} else if (eventType==XmlPullParser.END_TAG && xpp.getName().equalsIgnoreCase("Item")) {
                                                insideItem=false;
                                        }

                                        try {
                                                eventType = xpp.next();
                                        } catch (XmlPullParserException e) {

                                        } catch (IOException e) {           }
                                }
                                //stop();
                                //h.sendEmptyMessageDelayed(0, 3000);
                        }

                };
                t.start();

                final Handler h = new Handler();
                h.postDelayed(new Runnable() {
                        public void run () {

                                if (t.getState() == Thread.State.TERMINATED) {
                                        adapter = new
ArrayAdapter<String>(getApplicationContext(), android.R.layout.simple_list_item_1,
headlines);
                                        setListAdapter(adapter);

                                        return;
                                } else {
                                        h.postDelayed(this, 1000);
                                }
                        }}
                , 1000);
        }

        protected void onListItemClick(ListView l, View v, int position, long id) {
                //float lo = Float.valueOf((String) longs.get(position).toString());
                //float la = Float.valueOf((String) lats.get(position).toString());
                //String uri = String.format("geo:%f,%f", la,lo);

                //Open mapview with coordinates
                //String uri = String.format("geo:%f,%f", latitude, longitude);
                //Intent intent = new Intent(Intent.ACTION_VIEW, Uri.parse(uri));
                //context.startActivity(intent);

                Uri uri = Uri.parse((String) links.get(position));
            Intent intent = new Intent(Intent.ACTION_VIEW, uri);
            startActivity(intent);
        }

        @Override
        public boolean onCreateOptionsMenu(Menu menu) {
                getMenuInflater().inflate(R.menu.main, menu);
                return true;
        } }
```

APPENDIX 6

Acceptance letter for ResNes Doctoral Student Colloquium that coincided with the 2012 e-Skills Summit held in Cape Town, South Africa, 22-25 October 2012.

Letter of acceptance – ResNes Doctoral Student Colloquium:

Riana Steyn <Riana.Steyn@up.ac.za> Wed, Oct 17, 2012 at 2:23 PM

Cc: Carina DeVilliers <Carina.DeVilliers@up.ac.za>, Machdel Matthee <Machdel.Matthee@up.ac.za>, Hossana Twinomurinzi <twinoh@up.ac.za>

Good day,

Thank you for submitting your extended abstract for the 2012 Postgraduate Research Colloquium to be held in Cape Town on Saturday 27 October 2012.

We are pleased to announce that you will be able present your current research at the colloquium. Your final camera ready paper will be distributed to all the relevant parties before the colloquium to ensure that you get the maximum feedback on your research on the day. You will also have to present your research with a 30 min power point presentation on the day. Please send your presentation as well as your final camera ready paper on the 20th of October 2012. Please remember we need you final camera ready proposal by **20th of October 2012**, if you fail to submit on this day, your submission will be pulled from the colloquium.

As this colloquium follows the creative industries workshop which is held on the 26th and 27th, you are urged to also register for this workshop. Please register for the workshop and colloquium on the following website:

www.resnes.co.za

Any queries, please contact me directly and I will gladly assist.

Kind regards,

Riana Steyn

Organising Chair: 2012 Postgraduate Research Colloquium

Global ICT Forum on Human Capacity Development: "Digital Inclusion: Transition from Analogue to Digital Broadcasting", Cape Town, Republic of South Africa, 22-25 October 2012

Confirmation of registration – e-Skills Summit 2012

Dear **Mr Johan Breytenbach**,

Following your request, we are pleased to confirm your registration for the Global ICT Forum on Human Capacity Development: "Digital Inclusion: Transition from Analogue to Digital Broadcasting", to be held in Cape Town, Republic of South Africa, from 22-25 October 2012. The venue will be the Southern Sun Cape Sun - http://www.tsogosunhotels.com/hotels/cape-sun/pages/overview.aspx.

Your registration identification (ID) number to be quoted at all times is: **1054184**

Your identity badge will be available at the registration desk in the Southern Sun Cape Sun starting Sunday 21 October from 15h00.

To receive your badge, this e-mail confirmation must be presented at the registration desk along with your passport or national identity card.

Practical Information

Information regarding visa to South Africa, transport arrangements and hotel bookings can be found at http://academy.itu.int/moodle/course/view.php?id=551.

For more information please visit our website: http://academy.itu.int/events/item/1015/

If you need further information, do not hesitate to contact the secretariat of the Forum at HCB_GlobalForum2012@itu.int.

Regards

BDT Meeting Registration Service

APPENDIX 7

Letter of acceptance – Fifth Annual Pre-ICIS GlobDev Workshop, 2012

Sajda Qureshi <squreshi@pki.nebraska.edu> Tue, Nov 27, 2012 at 2:31 AM

To: Johan Breytenbach <breytenbachj@gmail.com>, Carina DeVilliers <carina.devilliers@up.ac.za>

Cc: Edward Stohr <estohr@stevens.edu>, Ojelanki Ngwenyama <ojelanki@ryerson.ca>

Dear Johan Breytenbach, and Carina de Villiers,

As workshop co-chair of the 5th Annual AIS Special Interest Group for Global Development (SIG GlobalDev) Workshop, I am pleased to inform you that your paper entitled "**Supply elasticity within the South African ICT labour market**", has been accepted for presentation and possible publication in the AIS eLibrary. Would you kindly edit your paper and format it as per the SigGlobDev authours instructions on the right hand side of the following site: http://www.globdev.org/and let us have your final revised paper as soon as possible.

Please proceed to register for the workshop at http://icis2012.aisnet.org/index.php/conf-registration as soon as possible to ensure inclusion of your paper in the proceedings.

Please also review the attached draft program and let me know soon of any scheduling conflicts or errors that may be associated with your paper.

Congratulations!

Sajda Qureshi
Co-Chair SigGlobDev Workshop

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