

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

Johan Breytenbach^a & Carina De Villiers^a

^a Department of Informatics, University of Pretoria, Lynnwood Road, Pretoria 0027, South Africa

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 <i>et al.</i> , 2008; Sen, 1999
2	Social embeddedness/Local ownership	Avgerou, 2000; Avgerou, 2009; Coetzee, 2010; Giddens, 1984; Pade-Khene <i>et al.</i> , 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 <i>et al.</i> , 2012
	Labour supply/Capacity building variables	
6	Project/institutional focus on industry readiness (matching supply with demand)	Bridgstock, 2011; Lotriet <i>et al.</i> , 2010; Merkoffer <i>et al.</i> , 2009
7	Project/institution provides prospective students/graduates with sufficient industry career information	Calitz, 2011; Walstrom <i>et al.</i> , 2008
8	Project/syllabus includes current scarce skills in subject matter (e.g. Java, C#, Mobile, SQL, BA)	Calitz <i>et al.</i> , 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 <i>et al.</i> , 2010; Bakhshi <i>et al.</i> , 2009; Bridgstock, 2011; Cunningham <i>et al.</i> , 2009; Flew, 2011
	Creative Industries/Employability variables	
16	Project/course/institution has trans disciplinary application focus	Banks & Deuze, 2009; Hearn <i>et al.</i> , 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 <i>et al.</i> , 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 (ISGDF)

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 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 and 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

The National Research Foundation (NRF) of South Africa and the Department of Communication, via the e-Skills Institute, are acknowledged for financial support for this project.

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 brochures, 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 direct 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, aptly 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 syllabus changes?	4	Yes, but this flexibility is only obtainable because of the flexibility 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	Changes were made in the syllabus 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 syllabus 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, brainstorming 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 of knowledge discussed in class?	2	Very few examples were given.
	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 copywrite, 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.

11) References

- Andersson, A., Grönlund, Å., & Wicander, G. (2012). Development as freedom – how the capability approach can be used in ICT4D research and practice. *Information Technology for Development, 18*(1), 1-4.
- Araya, D., & Peters, M.A. (2010). *Education in the creative economy: knowledge and learning in the age of innovation*. New York: Peter Lang.
- Avgerou, C. (2000). Recognising alternative rationalities in the deployment of information systems. *The Electronic Journal of Information Systems in Developing Countries, 3*(7), 1-15.
- Avgerou, C. (2009). Discourses on innovation and development in information systems in developing countries' research. *Assessing the Contribution of ICT to Development Goals, Dubai School of Government and International Federation for Information Processing*.
- Bakhshi, H., & McVittie, E. (2009). Creative supply-chain linkages and innovation: do the creative industries stimulate business innovation in the wider economy? *Innovation: Management, Policy & Practice, 11*(2), 169-189.
- Banks, J., & Deuze, M. (2009). Co-creative labour. *International Journal of Cultural Studies, 12*(5), 419-431.
- 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.
- Breytenbach, J., & De Villiers, C. (2013). Directing the South African ICT labour force towards growth sectors: a case for non-institutional mobile application development transition and reskilling courses. *Unpublished*.
- Breytenbach, J., De Villiers, C., & Jordaan, M. (2012). Communities in Control of Their Own Integrated Technology Development Processes. *Information Technology for Development, 18*(4), doi:10.1080/02681102.2012.714348.
- Bridgstock, R. (2011). Skills for creative industries graduate success, *Education + Training, 53*(1), 9-26. doi: 10.1108/00400911111102333.
- Calitz, A. (2011). *A model for the alignment of ICT education with business ICT skills requirements*. DBA thesis. Port Elizabeth: Department of Computer Science, Nelson Mandela Metropolitan University.
- Calitz, A., Greyling, J., & Cullen, M. (2010). The problems experienced within the e-skills value chain in South Africa. *Proceedings e-Skills Summit* (pp. 1-10). Cape Town, South Africa.
- Caves, R.E. (2003). Contracts between art and commerce. *Journal of Economic Perspectives, 17*(2), 73-84.
- Chigona, W., & Mooketsi, B. (2011). In the eyes of the media: discourse of an ICT4D project in a developing country. *The Electronic Journal on Information Systems in Developing Countries, 46*(6), 1-16.

Coetzee, L. (2010). *ICT for society through society: application of code-sprints as entrepreneurial enabler*. Paper presented at the 2010 Science Real and Relevant Conference. Retrieved from www.conference.csir.co.za

Cremer, P. (2011). *The South African ICT skills deficiency*. MIT mini-dissertation. Pretoria: Department of Informatics, University of Pretoria.

Cunningham, S., & Higgs, P. (2009). Measuring creative employment: implications for innovation policy. *Innovation: Management, Policy & Practice*, 11(2), 190-200.

Flew, T. (2011). *The creative industries: culture and policy*. Sydney: Sage Publications Limited.

Giddens, A. (1984). *The constitution of society: outline of the theory of structuration*. University of California Press.

Hearn, G., & Bridgstock, R. (2009). Educating for innovation, networks and transdisciplinarity in the knowledge economy. *ICERI2009 Proceedings*, p. 463.

Heeks, R. (2008). ICT4D 2.0: The next phase of applying ICT for international development. *Computer*, 26-33. Retrieved from <http://www.computer.org/portal/web/csdl/doi/10.1109/MC.2008.192>

ITWeb. (2011). Summary of main findings 2011 JCSE-ITWeb Skills Survey. Available online: http://www.mict.org.za/downloads/2010_Skills_Survey_Report_v2_1.pdf

Leem, C.S., Kim, B.W., Yu, E.J., & Paek, M.H. (2008). Information technology maturity stages and enterprise benchmarking: an empirical study. *Industrial Management & Data Systems*, 108(9), 1200-1218.

Lotriet, H., Matthee, M., & Alexander, P.M. (2010). Challenges in ascertaining ICT skills requirements in South Africa. *South African Computer Journal*, 46, 38-48. Retrieved from <http://sacj.cs.uct.ac.za/index.php/sacj/article/viewArticle/64>

Merkofer, P., & Murphy, A. (2010). The e-skills landscape in South Africa. *Zeitschrift für Politikberatung*, 2(4), 685-695. doi:10.1007/s12392-010-0219-y

MICT SETA. (2011). *ISETT SETA Sector Skills Plan 2011 – 2016*, Version v2p1. Available online: <http://goo.gl/J3qQB>

Pade-Khene, C., Mallinson, B. & Sewry, D. (2011). Sustainable rural ICT project management practice for developing countries: investigating the Dwesa and RUMEP projects. *Information Technology for Development*, 17(3), 187-212.

Sen, A. (1999). *Development as freedom* (2nd ed.). Oxford: Oxford University Press.

Sen, A. (2009). *The idea of justice*. London: Penguin Books.

Stolarick, K., Mellander, C., & Florida, R. (2010). Creative jobs, industries and places. *Industry and Innovation*, 17(1), 1-4. doi:10.1080/13662710903573794

Toner, P. (2011). *Workforce skills and innovation. An overview of major themes in the literature.* OECD Working Paper Series. Available online: <http://goo.gl/2VKKKe>

Twinomurinzi, H. (2012). The role of ICT in sustainable and responsible development: e-skilling. *ICT Critical Infrastructures and Society*, 386(1), 90-99.

Walstrom, K.A., Schambach, T.P., Jones, K.T., & Crampton, W.J. (2008). Why are students not majoring in information systems? *Journal of Information Systems Education*, 19(1), 43-53.