Describing the IS Professional with a Structural Model

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Abstract

This paper presents a dynamic structural model of the relative contribution and importance of education and skills required of new information systems (IS) professionals. Model development took account of technical skills found in most IS programs, other business oriented academic studies, and soft skills sought by employers in new graduates. The model also includes features of the working environment which influence the career progress of IS graduates.

Acknowledging the importance of these four areas, the authors present a second order structural model that links these areas and compare the application of this model to IS students and decision makers who employ graduate our graduates. The model fits the data for the two groups and exhibits some unexpected outcomes in the area of soft skills with students indicate this is more important than do IS managers.

The model allows, with some confidence, a quantitative interpretation of the relative importance of the respective variables from the perspectives of the student and employer stakeholder groups toward the education and professional development of IS professionals.

Keywords: Information Systems, IS professional, IS graduates, technical skills, soft skills, hard skills, structural model.

1. Introduction

Much has been written about the quality of IS graduates and their expectations. Employers are often critical of the lack of practical experience or the unrealistic views young graduates hold. Graduates should not be held responsible for their lack of experience, yet neither should they expect top positions.

The discrepancy between what employers seek in graduates and what IS programs in universities produce is also of concern. It is clear that there is an interaction between the competing aspects in the development and education of IS graduates. How can these interactions be measured? The purpose of this paper is to present the results of a study utilising structural equation modelling methods to develop and validate a model that illustrates the possible relationships between these areas and the emphasis that students and IS decision makers place on these.

2. IS Graduate Skills

Much work has been done investigating skill requirements of IS graduates including soft skills (Ross et al. 1993; Van Slyke et al. 1997), hard skills and job features (McLean et al.
that are motivating factors for IS graduates. Some of these compare various stakeholders such as academics and industry, or student perceptions (Ahmadi et al. 1997-1998; Cappel 2001/2002; Farwell et al. 1993; Farwell et al. 1995; Goles 2001; Lee et al. 2002; Orr et al. 2000; Williams 1998; Wong 1996; Woratscheck et al. 2002). In the main they have been descriptive in nature covering curriculum emphasis usually with, skills rated in order of importance. The next section briefly discusses the literature and previous research relating IS graduate skills and is organised under headings describing broadly those skills.

2.1. Interpersonal and communication skills

The interpersonal skills are viewed by some as just as important as technical skills (Young 1996; Young et al. 1997). Others stress the need for IS students to develop skills and abilities in various areas including teamwork, creativity and communication and a capstone course has been proposed to achieve these aims (Gupta et al. 1998). The changing role of the IS/IT professional and the skills/competencies required for development in the early twenty first century have been identified (Kakabadse et al. 2000).

An early study by Young (Young 1996) which looked at the importance of a range of technical and interpersonal skills to industry when employing new IS personnel was replicated in a study of students from differing backgrounds (Weber et al. 2001). Differences in student perception of industry requirements that was based on background and gender was reported (Weber et al. 2001).

2.2. Technical skills

It is argued that specific technical skills are less important than basic technical skills and non-academic skills (Van Slyke 1997). Doke and Williams (1999), in a study across various IS job classifications, found that systems development skills and interpersonal skills were common across classifications but programming skills were more important for entry level IS positions. Similar results were obtained in a pilot study of 102 students and 54 employers of IS graduates (Turner et al. 1999).

Several authors have attempted to develop a standard list of technical skills that identify a typical IT professional. Examples include (Rada 1999) who proposed a portfolio of forty technical skills and (Todd et al. 1995) who performed a content analysis of IS job advertisements over a twenty year period from 1970 until 1990 covering sought-after skills. (Litecky et al. 2001) developed a list of thirty-eight technical skills that were in demand for a typical IT professional. These authors carried out a content analysis of 20,000 job advertisements that appeared in newspapers and the Internet over a ten period from nine major metropolitan areas across the US. Ranking the top skills during the 1999 survey period.

2.3. Business and other skills

In contrast however, IS education is often seen as concentrating too much on a narrow set of technical skills and it is suggested that the IS curricula should concentrate on developing technical & business skills, working in a collaborative setting, instilling a sensitivity to social and organizational impacts and to inculcate the ability to self-learn in a rapidly changing technological environment ((Ross et al. 1993). Despite the call from IS employers for more business orientated skills in exiting IS students, core business subjects do not rate highly (Ashley et al. 1997; Turner et al. 2001).

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Technical skills are not the total answer in preparing the IS professional. Many system shortcomings arise from the fact that IS educators do not address business objectives and neither are they sensitive to user needs or concerns (Ross et al. 1993). Programs aimed at developing IS professionals of the future must cover a wide range of skills and assist the integration of these skills in complex environments. (Little et al. 1999) suggest that it is not sufficient for CIT graduates to just have technical capabilities but there needs to be an awareness of the need for professionals to have responsibility for their work and the importance of appropriate ethical behaviours. They further suggest a need to include these aspects in the curriculum of current CIT programmes. Little et al. (1999) argue that there is an “industry-academic gap” that leads to dissatisfaction amongst employer groups with CIT graduates and suggest that professionalism and workplace issues, or lack of these, in CIT curricula is a reason for this gap.

(Calitz et al. 1997) endeavoured to find predictors to success in matriculating high school students. They identified several new performance and psychometric criteria useful in selecting IT students. In addition they identified non-technical skills that are important for success in a business environment including Business knowledge and social skills, and communication skills, are important criteria. They particularly note importance of English language, and especially technical English. In addition they observed that while the investigative personality type succeeds in the IT industry, the social personality type is becoming increasingly important.

In summary (Westfall 1998) asserts “Information technology literacy must include (but is not limited to):

- knowledge that covers the breadth of the field at the current point in time
- practical, hands-on experience learning and using new information technologies
- an understanding of what makes specific new information technologies more important than others
- knowledge of economic factors and trends that will lead to new information technologies and to obsolescence or devaluation of existing technologies
- an understanding of the relationship between career choices and specific information technologies
- knowledge of the critical importance of continuous learning, and skills for maintaining and extending knowledge in this field on a self-service basis, to supplement continuing formal education and training “ (Westfall 1998)

2.4. Role of professional bodies and educators

Determining the skills employers of new IS graduates seek is important for educators in designing curricula and advising students. The education sector provides core skills for industry to develop and to maintain competitive advantage but the onus is on the IT industry to obtain skilled workers and to train existing staff and provide opportunities for the new entrants (NOIE 1999). There have been attempts to define a core set of generic attributes required of an IS graduate (Snoke et al. 1998a; Snoke et al. 1998b; Snoke et al. 1999; Snoke et al. 2000; Snoke et al. 2002). Core curriculum requirements have been set in association with professional bodies in Australia (Underwood 1997) and the USA(ACM-AIS New York 2002; Davis et al. 2001; Davis et al. 1997; Lidtke et al. 2000; Mawhinney et al. 1999; Mehic et al. 1999). However, it has been suggested the course requirements surrounding the IS 2002 model curriculum as it stands contains probably more technical material than can be covered in a single course (Beachboard et al. 2003). Others have reported that “it is also not
economical for schools to teach students material they can learn more efficiently after graduation” (Lee et al. 2001)

As highlighted in the literature the industry and IS educators face a dilemma with the IS profession being “pulled in opposite directions” ((Wyczza et al. 1999). One the human orientation and the other towards the technical skill. (Hemingway et al. 2000) suggest that the IS/IT profession is handicapped by the differing needs of business and geography. The range of activities IS professionals are called upon to perform leads to a lack of formal career structure (Hemingway et al. 2000, p179) that matches skills with roles causing confusion among stakeholders. Nevertheless, (Gillard 2000) maintains that there should be two aspects of a university course that require consideration – employer expectations of graduates and student preparedness on entry to a course. The research reported here explores further this issue.

3. Method

The authors developed a multipart questionnaire to solicit views of IS students and employers on the importance of core non-IS subjects, personal skills and attributes, and a number of work features and incentives that are appealing to graduates seeking employment in the field.

Instrument content included items found in previous surveys and additional items added by the authors. (Cappel 2001/2002; Cheney 1988; Cheney et al. 1980; Farwell et al. 1995; Leitheiser 1992; Leonard 1999; Snoke et al. 1998b; Tang et al. Winter 2001; Trauth et al. 1993; Van Slyke et al. 1997). Questions covered technical topics found in undergraduate IS degree programmes, core non-IS subjects, personal skills/attributes and a number of work features and incentives that are appealing to graduates seeking employment in the field.

The questionnaire was administered to senior undergraduate students in Information Systems at three universities in Victoria, Australia. The three universities yielded 254 responses from 300 distributed to students during regular classes. For IS managers and decision makers, a personally addressed email message was sent to a mailing list of employers inviting participation in the survey. The survey was sent to 2000 IS decision makers in organizations around Australia using a commercial e-mailing service who supplied the list. A total of 241 responses from this list were returned as failed deliveries or as requests to opt out of future mailings. The response for this survey resulted in 153 returns with 138 being usable or 7.8 percent response rate

4. Analysis

Item reliability was tested using Cronbach’s $\alpha$. Item reliability was good with the overall value for each subscale exceeding the recognised benchmark value of 0.7. Summated scales were computed using a weighted mean approach (Hair et al. 1998; Holmes-Smith et al. 1994) where the mean scores are multiplied by the respective factor loadings, summed and divided by the sum of the factor loadings. This ensures that the factor loadings are properly and fully taken into account when computing the summated scales.

Nine factors were identified through exploratory factor analysis. Factor analysis was performed on the items in the questionnaire using PCA analysis with Varimax rotation. Questions that did not clearly load onto a single factor or which did not have a value of at least 0.5 were excised from the analysis.

Nine separate factors in four separate areas of interest were identified as follows:
1. Three factors (F1W, F2W and F3W) were identified as IS academic subjects and these were measured by eight questions.

2. Two factors (OAF1W and OAF2W) measured by eight questions were identified as non-IS academic subject areas and

3. Two factors (SF1W and SF2W) were identified as soft skills and these were measured by eight questions.

4. Two factors (WF1W and WF2W) concerned work related incentives and these were measured by seven questions.

An interpretation of these factors is given in Table 1 below.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Interpretation</th>
<th>Emphasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1W</td>
<td>IS academic subjects</td>
<td>High level applications</td>
</tr>
<tr>
<td>F2W</td>
<td>IS academic subjects</td>
<td>Design and development</td>
</tr>
<tr>
<td>F3W</td>
<td>IS academic subjects</td>
<td>Web related applications</td>
</tr>
<tr>
<td>OAF1W</td>
<td>Non-IS academic subjects</td>
<td>Inwardly focussed core non-IS business subjects</td>
</tr>
</tbody>
</table>

Two factors pertain to the IS job and its features, two are related to soft skills and personal qualities, and five were concerned with educational matters from IS technical areas (three items) and non-IS academic areas (two items).

5. Developing the Structural Model

Structural equation modelling requires comparatively large data sets to be truly effective. With just 253 usable cases from students and 136 from IS decision makers, the authors were concerned that there were too few cases for sensitive analysis. This concern was not without foundation. The basic model had 30 manifest variables requiring nearly 1300 returns (Hair et al. 1998).

To address this concern, individual variables were combined into composite variables, based on the respective questions and factors on which those questions loaded. Following the method outlined by Holmes-Smith & Rowe (Holmes-Smith et al. 1994), Hair, Anderson et al, (Hair et al. 1998) and Hughes, Price et al (Hughes et al. 1986) composite factor measurement models were developed to reduce the complexity of the model and to reduce the number of returns required for a reliable model. The various latent variables in the model are replaced by the calculated composite variable that is then treated as a distinct manifest or measurement variable (Hair et al. 1998). This approach reduced the number of returns needed for development of a structural model to approximately 200 - a more realistic figure.
The maximum likelihood (ML) method was adopted for model fitting. This method is often used in structural equation modelling (Hair et al. 1998; Wang et al. 2001). The structural model developed during this study has four latent variables. They are:

1. **Soft skills:** includes interpersonal skills and team work;
2. **IS ed:** includes IS education skills outcomes and technical skills such as web development, analysis and design;
3. **Non-IS ed:** includes non-academic subjects such as accounting, economics and commercial law;
4. **Work aspects:** includes aspects of the work environment that may influence the IS professional.

The dependent variable, *IS Professional*, is the result of the interaction of soft skills, education and work environment. Figure 1 shows the structural models derived from IS student data.

![Figure 1: Standardised Structural Model: IS Students](image)

Figure 2 below shows the structural model derived from the responses of IS Managers. To be valid a model must be tested against other sets of independent data. In the present case this was done with data from IS decision makers and managers. Table 2 shows the values of the various normality tests applied to the variables in the structural model. The values for kurtosis and skewness are each within the acceptable range of between ±2. (Garson, undated). Chi square is sensitive to sample size and p values alone should not be relied upon when sample size is larger than about 100 (Hair et al. 1998)
As no single fit measure has been developed, a number of fit measures are usually presented. The measures and the values for an acceptable fit are presented in Table 2, below ((Hodgson 1999; Murray 1997; Schumacker et al. 1996))
Chi square is sensitive to sample size and p values alone should not be relied upon when sample size is larger than about 100 (Hair et al. 1998)

The fit parameters show excellent fit and within the acceptable levels. For the student cohort, the model fit values are GFI=0.96, AGFI=0.94, TLI=0.97, RMSEA=0.04 (range LO90=0.04, HI90=0.07), RMR=0.025, p=0.07 and CMIN (discrep)=1.46. These values all indicate the model fit is sound as it stands and because of the interest in maintaining a parsimonious model, the application of modification indices to further improve the model applied to students was not pursued.

The fit values for IS managers are also very good with GFI=0.93, AGFI=0.90, TLI=0.94, RMSEA=0.065 (range LO90=0.024, HI90=0.099), RMR=0.042, p=0.025 and CMIN (discrep)=1.58. The range of values for RMSEA is a little high but the average value is within acceptable levels. As in the case of the students, standardized residual covariance values between indicators are each below the critical value suggest by (Hair et al. 1998) of 2.58, confirming they are significant at the 0.05 level and supporting the fit of the model to the data.

Table 3 shows the standardised regression coefficients determined for the two groups. For the student data and IS managers, the un-standardized regression coefficients are significant at p<0.001 critical ratios great than 2. Values for the regression weight below 0.3 are considered as weak, between 0.3 and 0.5 as mild and above these values as strong (Holmes-Smith 2000). From Table 3 it can be seen that all regression weights are at sound and above at least 0.4 for both the student group and IS managers.

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Students</th>
<th>IS managers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS managers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>non-IS ed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Professional</td>
<td>.726</td>
<td>.788</td>
</tr>
<tr>
<td>IS ed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Professional</td>
<td>.775</td>
<td>.754</td>
</tr>
<tr>
<td>soft skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Professional</td>
<td>.957</td>
<td>.907</td>
</tr>
<tr>
<td>work_aspects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Professional</td>
<td>.943</td>
<td>.898</td>
</tr>
<tr>
<td>Variable</td>
<td>Description</td>
<td>Regression Weight</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>SF2W</td>
<td>soft skills</td>
<td>0.688</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.603</td>
</tr>
<tr>
<td>F1W</td>
<td>IS ed</td>
<td>0.654</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.679</td>
</tr>
<tr>
<td>F3W</td>
<td>IS ed</td>
<td>0.533</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.595</td>
</tr>
<tr>
<td>OAF2W</td>
<td>non-IS ed</td>
<td>0.710</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.742</td>
</tr>
<tr>
<td>SF1W</td>
<td>soft skills</td>
<td>0.702</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.553</td>
</tr>
<tr>
<td>F2W</td>
<td>IS ed</td>
<td>0.640</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.625</td>
</tr>
<tr>
<td>OAF1W</td>
<td>non-IS ed</td>
<td>0.654</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.715</td>
</tr>
<tr>
<td>WF1W</td>
<td>work_aspects</td>
<td>0.572</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.487</td>
</tr>
<tr>
<td>WF2W</td>
<td>work_aspects</td>
<td>0.682</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.582</td>
</tr>
</tbody>
</table>

**Table 3: Standardized Regression Weights**
Squared multiple correlations ($R^2$ values) presented in Table 4 are, with the exception of F3W for students and for IS managers, WF1W above the recommended minium value of 0.3 suggesting item reliability is good (Holmes-Smith 2000). Somewhat unexpectedly the variable F3W which relates to web development matters is relatively weak for the student group. The construct WF1W, concerned with environmental and comfort factors is relatively weak for IS Managers.

As a further indicator of the model being acceptable, standardized residual covariance values between indicators are each below the critical value of 2.58 suggest by (Hair et al. 1998)confirming they are significant at the 0.05 level.

The model indicates solid contributions from each group with a slightly lower emphasis on non-IS educational matters for students compared to IS managers. There is little difference between the two concerning the construct IS ed concerned with the technical side of formal education. There is some difference displayed for the non-technical side of formal education with IS managers showing a stronger response (0.79) compared to students (0.70). Work aspects and soft skills are slightly stronger for students than for IS managers.

The model shows substantial differences between students and IS managers concerning the regression weights of the latent variables onto the composite measures. The student group exhibits stronger weightings for work aspects and soft skills for all measures, especially when it concerns getting on with people (SF1). There are differences however when the education measures are compared. IS managers indicate design and development (F2W) and web related applications (F3W) are stronger than for students. On the other hand, students indicate high level applications (F1W) are slightly stronger. For non-technical education the student group shows less emphasis on the inwardly focussed core non-IS business subjects (such as economics and statistics) but more on the outwardly orientated non-IS subjects (such as management and marketing).
6. Discussion

Most research published in the area of skills are based on one aspect of the IS professional. Much has been published on technical skill required as perceived by the various stakeholders or comparing the perceptions of stakeholders. There is a body of work illustrating the growing importance of soft skills, again from the perspective of various stakeholders. Research has also been published concerning the effects of the working environment on IS professional perceptions of their work situation. Some work has been presented illustrating the importance placed on business related skills acquired as part of the IS graduate’s preparation.

To the authors’ knowledge, no research has appeared which links these areas together via a structural model. The work presented in the research reported in this paper addresses this issue. The research suggests that there is a relationship between these four factors and shows the relative importance and strength of the factors. This is important since conventional factor analysis does not allow for the comparison in the significance of these factors. This limitation is not present in structural equation modelling. For the first time it is possible to show the interacting relationships of the four factors along with their relative importance.

When applied to students and to IS managers the model shows a good fit for both sets of data. One of the important requirements for any model is that it is able to be fitted to independent sets of data. This requirement is satisfied in this case.

The results presented in this paper indicate that the perceptions of both students and IS managers of the IS professional can be described by a second order, four latent factor model described in terms of hard IS skills, non-IS educational skills, personal attributes and soft skills, and job conditions.

It should be stressed that the model is not necessarily the only one that can fit the data. It does however show that there is possible to develop a comprehensive model to explain the various attributes of the IS professional. Ultimately it is hoped that a refined structural model can be useful in improving the career prospects of new graduates.

The model is currently being tested against other stakeholder groups such as academics engaged in teaching IS students and also IS practitioners. The results so far are promising.

References


**Appendix: Survey question variables used in the study**

**IS Subjects**

- Analysis & Design of Information Systems
- LAN operations & data communications
- Web page design & development
- Knowledge base or expert systems
- Able to apply 3GL programming languages
- CASE tool applications
- Project management
- Client-server applications
- ERP implementation & operations
- Business application of computers
- Database design
- E-commerce/E-business development
- Knowledge of PC applications
- Able to apply object oriented languages
- Large computer system experience/knowledge
- Use of operating systems
- Data mining / Data warehousing

**Other Business Subjects**

- Accounting
- Business ethics
- Business statistics
- Knowledge of foreign languages other than English
- Communications & report writing
- Marketing
- Mathematical modelling
- International business
- Business finance
- Business or commercial law
- Economics
- Psychology
- Management
- Operations research
- Organizational behaviour

**Soft Skills**

- Ability to accept direction
- Able to independently acquire new skills
- Able to meet deadlines
- Able to think creatively
- Able to work under pressure
- Business analysis skills
- Information seeking skills
- Have leadership potential
- Have problem definition skills
- Time management skills
- Have written communication skills
- Able to work with people of different disciplines
- Able to quickly apply new skills
- Good sense of humour
- Able to work as part of a team
- Able to work independently
- Place organizational objectives first
- Able to prepare multimedia presentations
- Be client focussed
- Have oral presentation skills
- Have problem solving skills
- Willing to undergo on going professional development
- Able to interact with people of different backgrounds
- Able to handle concurrent tasks

**Work incentives**

- Good promotional prospects within the company
- A friendly work environment
- Provision for on-going training
- Flexible working conditions
- Supportive superiors
- Fringe benefits (eg company shares, car etc)
- Opportunities for travel
- Challenging work assignments
- An industry competitive salary
- Reliable internal communications
- Opportunities to expand personal skills