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Towards a General Framework for the Study of ICT Skill Supply and Demand

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ABSTRACT

New technology and changing business needs will change the job requirements and responsibilities of the future. Companies will expect their IT employees to combine business skills, analytical thinking and the ability to exhibit expertise in an array of technology areas. This paper provides a framework for addressing the skills demanded by industry and the knowledge for those skills supplied by academia. In addition the framework could be used by students, academics, and industry to identify the skill set that will meet the needs of today's dynamic business environment.

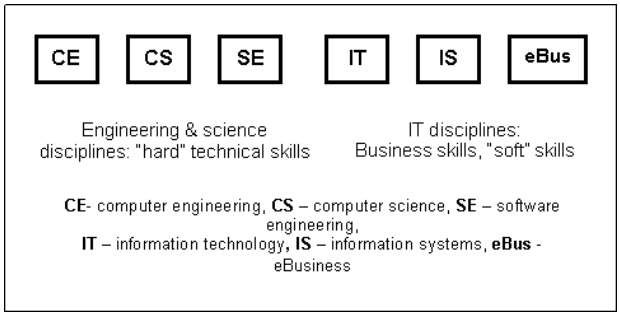
INTRODUCTION

In the last decade, a fast growing process of convergence between information and communication technologies has led to the widespread use of the comprehensive term ICT ("ICTs") with reference both to academic programmes and to the information technology industry. This umbrella term covers almost the whole spectrum of the academic disciplines previously referred to as "computing", and also includes eBusiness. Consequently the information systems (IS) and information technology (IT) academic curricula have become more inclusive; most contemporary undergraduate ICT programmes are aligned along the continuum of discipline groupings shown in Figure 1.

Historically, two types of skill sets have underpinned undergraduate ICT curricula (Litecky, Arnett, & Prabhakar, 2004). Engineering and science programmes have primarily been aimed at the development of technical and technological capabilities ("hard" skills). IT/IS programmes have placed sufficient emphasis on those but have also recognised the importance of producing graduates who understand business processes, and possess "soft" skills (including interpersonal and communication skills).

ICT curriculum development is driven by the need to meet changing job market requirements and employer demands. However academia does not generally respond automatically (or quickly) to the industrial environment, nor is its response always a successful match to the current industry requirements. While the noticeable delay in supplying programmes and graduates matching closely the expectations of the labour market is due in part to the traditionally conservative nature of the academic sector, and to operational difficulties, some authors studying the relationship between curricula design and industry requirements have attributed the lack of speedier response to the lack of motivation within academia itself (Chandra, March, Mukherjee et al., 2000; Davis, Siau, & Dhenuvakonda, 2003).

Figure 1. ICT educational groupings and skills (Adapted from Shackelford, 2004)



Another factor contributing to the gap between ICT curricula and the demands of the ICT industry is the significant change in the pattern of job requirements (Lee, Trauth, & Farwell, 1995; Lee, 2002; Gallivan, Truex, & Kvasny, 2004). Further, it should be noted that the nature of the IT profession itself is changing and so are the expectations of the market. The IT evolution has been and should continue to be reflected in the roles and jobs of IT professionals, but it is also necessary for the outcomes of ICT education to meet the demands of the new job opportunities.

MOTIVATION AND OBJECTIVE

Past research has focused on the identification of critical ICT skills and capabilities, on curriculum development, and also on issues related to cultural and socio-economic differences. However the literature on how academia should develop ICT graduates and meet the needs of the ICT industry has produced at times contradictory findings: Moore & Streib (1989), argued that "academia needs to place a greater emphasis on the basis of education, leaving the job specific skills to the corporate training environment", whereas Lee et al. (1995) suggested that "current IS curricula ... are not well aligned with business needs", and concluded that the "IS curriculum design must be driven by a clear vision of the career path of the graduates". Currently, voices from the ICT industry express concern about the lack of "solid foundational education in CS and IT principles" (Reisman, 2005), but also predict the need for even greater specialization by 2010 (Williams, 2004).

Mixed results have been produced about the importance and the criticality of the types of skills and capabilities needed by the ICT industry ("business" versus "technical"). Authors have used a variety of skill classification schemes to study these differences (for example Couger et al., 1995; Lee, Koh, Yen, & Tang, 2002; Gallivan et al., 2004).

This study was motivated by results from the authors' prior work in IT/IS skill and capability development (Medlin, 2004; Petrova & Claxton, 2005). It was found that the existing inconsistencies between the perceptions of students and employers might have been influenced by a number of specific factors. A review of the literature indicated that in the current environment, IT/IS skill sets and capabilities have become globally transferable (Lee, 2005) and that ICT students and graduates are now internationally mobile (West & Bogumil, 2001). However, regional differences might exist: contrary to assumptions Lee (2002) found that in Singapore technical skills were more in demand compared to business/interpersonal skills, if judged by published advertisements.

In this paper, a framework representing the dynamics of the ICT profession supply and demand sides ("academia" and "industry", respectively) is developed and discussed. It will facilitate further study of the relationships between the ICT job market and ICT tertiary education in a global context, with a view of informing ICT curriculum development and domestic and international student recruitment.

The rest of the paper is organised as follows: In the next section some findings from prior research are summarised. The following section introduces a framework representing the relationships between academia and industry in the context of ICT and identifies its research perspectives. The last section concludes with a brief discussion of possible directions for further research.

ICT SKILL SETS

Current and past research results have revealed significant changes in the ICT skill demand patterns (Lee et al., 1995; Lee, 2002; Gallivan et al., 2004) and has put a pressure on academia to produce employable graduates, requiring an ongoing effort in IS and IT curricula development (Couger et al., 1995; Petersen & Wehmeyer, 2004; Shackelford et al., 2004). The research literature on developing ICT skills and capabilities through curricula aiming at meeting relevant industry demands typically draws on data collected from multiple sources. Two basic types of research approaches can be identified: 1) studies based on data available in the public domain, and 2) studies where data are collected from human participants through a variety of data collection techniques.

The number of research works which analyze the content of published data is significant. Examples of data sources used include job advertisements in newspapers and journals (Gallivan et al., 2002; 2004), online job advertisement sites (Davies et al., 2003), Web sites of IT corporations (Lee, 2005), ICT curriculum documentation (Tang, Lee, & Koh, 2001). Data collected from these sources are used to identify skills and capabilities in demand by industry and to gauge the degree to which university curricula supply graduates with the required qualities.

Stakeholder groups from industry and academia are also used to gather data and identify and compare perceptions and expectations; the data gathering techniques include questionnaires, interviews, focus groups and discussions. Some studies use multiple data sources –employers and students (Petrova & Claxton, 2005), industry and school managers (Yen, Chen, Lee, & Koh, 2003), academics and practitioners (Lee et al., 2002). Additionally, IT/IS skill sets have been used to compare results from a cross-cultural, gender, or regional perspective (Pick, Mallen, Navarrette et al., 1998; Von Hellens & Nielsen, 2001; Burn, Ng Tye, Ma, & Poon, 1994; Lee, 2002; Yen et al., 2003), or in an emerging area such as Web development/eCommerce (Wade & Parent, 2002).

Implementing an approach similar to the one used by Duncan (1979) to classify organizational environments, Table 1 represents a four way classification of the skill sets identified and used in prior research reviewed; sources include joint investigations such as (Lee et al., 2002).

The variations between the classification schemes make it difficult to compare results (Gallivan et al., 2004). While the use of different sources might explain some of the differences, another factor might be the continuing evolution of the IT function within the organization: as it moves towards quality and precision of service, the supporting organizational structure changes from hierarchical to horizontal or matrix (Segars & Hendrickson, 2000). In such environments both highly specialised technical skills and excellent interpersonal and collaborative skills are in high demand (Duncan, 1979).

Despite the observed variation, there exists a commonality between the different research approaches. It allows for the representation of the main motifs in the study of ICT professional career development from academia to industry in a general framework which is introduced and discussed in the next section.

Table 1. ICT skill sets: environments and sources

	Education	Industry
People	Findings from studies where skill sets were derived from interviews, focus groups and surveys of students: Medlin et al. (2001); Weber et al. (2001); Medlin (2004); Petrova & Claxton (2005). • Technical/Business systems development & Design; • Managerial; • Analytical; • Communication / Interpersonal / Generic.	Findings based on skill sets derived from interviews, focus groups and questionnaires to ICT professionals: Lee et al. (1995); Bailey & Stefaniak (1999); Cash et al. (2004). • Technical/Technology management; • Non-technical / Soft (relationship management, conceptual / intellectual, interpersonal / management); • Non-technical: Business/Business functional.
Publications	Findings based on skill sets derived from ICT curricula: Ng Tye et al. (1995); Tang et al. (2001). • Applications; • Business/organization and society; • Analysis and design; • Environment / Platform/Technology; • Programming / Computer Languages; • Interpersonal / Personal.	Findings based on skill sets derived from job advertisements: Davis et al. (2003); Gallivan et al. (2002; 2004); Lee (2002); Lee (2005). • Management; • Business;; • Technical (software, hardware, development); • Social / Non-technical (communication, interpersonal); • Systems/Problem solving.

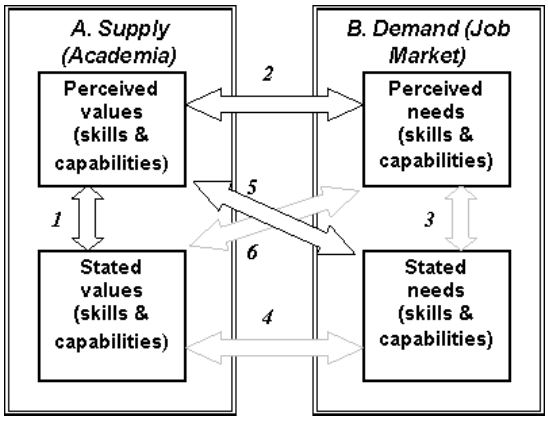
A FRAMEWORK FOR THE STUDY OF ICT SKILL SUPPLY AND DEMAND

The two main entities in the proposed framework (Figure 2) are ICT skill supply (academia) and ICT skill demand (job market). 'Academia' includes the stakeholders involved in developing and supplying ICT skills (educators, and students – future IT practitioners), and the means of developing ICT skills, knowledge and capabilities (the academic curricula of universities and other tertiary education institutions). 'Job market' represents the stakeholders demanding ICT professionals with relevant skills and capabilities and hiring them as ICT staff (employers and IT practitioners), and also the means of announcing ICT job requirements (job advertisements).

The framework builds on previous research related and includes all stakeholders and sources. Applying the framework it will be possible to compare the perceptions and expectations of stakeholder groups involved in supplying ICT graduates, and stakeholder groups creating the demand for specific skills. The framework also differentiates between 'perceived' and 'stated' values or needs (for example IT executives' expectations, and advertised job requirements). Several research perspectives for further comparative studies exist:

1. A comparison between students' perceptions about the value of their ICT skills and capabilities acquired through academic study, compared to the stated learning outcomes of the course of study

Figure 2. ICT skills: supply and demand framework



undertaken. The results of such an investigation might be used as a measure of the successful delivery of a programme, especially when new programmes are introduced under the pressure to align ICT education with ICT practice (Ng Tye, Poon, & Burn, 1995).

2. A comparison between students' perceptions about the value of their acquired ICT skills and capabilities and the expectations of their future employers about the needed ICT skills and capabilities. Results obtained might be used to inform short-term ICT curricula updating and keeping 'current', and to forecast long-term changes (Petrova & Claxton, 2005). Another aspect is IT employer profiling: for example, published data (ITAA, 2001) show that "non-IT companies" are the largest employer of IT workers and therefore it might be important to investigate whether non-IT employers have different requirements compared to IT employers and how well these differences are understood by future ICT professionals.
3. A comparison between the expectations of ICT employers about skills and capabilities needed in the workplace, and the skills and capabilities explicitly mentioned when job positions are advertised. Prior research has shown that an ever increasing number and variety of skills are required of newly hired ICT staff (Gallivan, et al., 2002), and that job advertisements might overemphasise certain skills (Lee, 2002; Gallivan et al., 2004). Results might be used to measure the reliability of job advertisements as a predictor of the actual need of ICT skills and might contribute to the understanding of the "paradox of soft skills vs. hard skills" (Litecky et al., 2004).
4. A comparison between graduate profiles (as described in academic programmes) and industry needs as reflected in job advertisements. Results from this comparison might have implications for aligning ICT curricula with globally recognised ICT needs and maintaining skills and capabilities transferability (Lee, 2005), and for identifying the suitable educational discipline mix required for building IS managerial skills compared to programmer /system analysts skills (Lee, 2002).
5. A comparison between students' perceptions of their ICT skills and the degree to which these match job market requirements, based on job advertisements (ICT graduates' employability as perceived by students). Results might have implications for the choice of strategies used to market academic programmes globally and taking into consideration the trend for international recruitment of ICT labour (Gallivan et al., 2004).
6. A comparison between employers' perceptions of ICT skills and capabilities as advertised in academic documentation and the degree to which stated learning outcomes match expectations (ICT graduates' employability as perceived by ICT employers). Results might have implications for decisions about aligning academic curricula with emerging requirements such as eBusiness knowledge (Cash, Yoong, & Huff, 2004), or with skills specifically predicted to be in high demand by – for example, middleware technologies (Niederman, 2004).

Furthermore, studies involving multi-party comparisons can be also conducted, to validate conclusions reached and to test them in different country settings or in specific contexts.

CONCLUSION

The framework captures the relationships both between and within academia and the ICT job market. It does not include external entities and relationships which could be contributing to the changes in the demand patterns of ICT skills and capabilities, driving in turn changes in supply patterns. However it offers a high level view of the dynamic links between ICT skill supply and demand and might be used for long-term planning and decision making.

As a means of testing the framework with a concrete study, we propose to compare student perceptions and the corresponding graduate profiles in a two-country setting, aiming to identify possible gaps in curriculum development and/or delivery (Research Perspective 1) and to analyse the implications, following up on previous findings.

With a focus on students as stakeholders and building on prior work (Weber, McIntyre & Schmidt, 2001; Lee et al., 2005; Medlin, 2004), directions for further research include an investigation of the relationships and the differences in students and employers' perceptions and a study of the factors contributing to the gap between students' perceptions and job market demands (Research Perspectives 2 and 5). A practical dimension might be added by providing an exemplary curriculum (Research Perspectives 4 and 6) which matches a set of demands identified through an investigation of the change in skill requirements following the evolution of the IT function (Research Perspective 3).

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REFERENCES

1. Bailey, J. L. & Stefaniak, G. (1999). "Preparing the information technology workforce for the new millennium". *ACM SIGCPR Computer Personnel*, *20*(4), 4-15.
2. Burn, J. M., Ng Tye, E. M. W., Ma, L. C. K., & Poon, R. S. K. (1994). "Job expectations of IS professionals in Hong Kong". *Proceedings of ACM SIGCPR'94*, pp. 231-241.
3. Cash, E., Yoong, P., & Huff, S. (2004). "The impact of e-commerce on the role of IS professionals". *ACM SIGMIS Database*, *35*(3), 50-63.
4. Chandra, J., March, S. T., Mukherjee, S., Pape, W., Ramesh, R., Rao, H. R., & Waddoups, R. O. (2000), "Information systems frontiers". *Communications of the ACM 43(1)*, 71-79.
5. Couger, J. D., Davis, G. B., Dologite, D. G., Feinstein, D. L, Gorgone, J. T., Jenkins, A. M., Kasper, G. M., Little, J. C., Longenecker Jr., H. E., & Valacich, J. S. (1995). "IS'95: guideline for undergraduate IS curriculum." *MIS Quarterly*, *19*(3), 341-359.
6. Davis, S., Siau, K., & Dhenuvakonda, K. (2003). "A fit-gap analysis of e-Business curricula vs. industry needs". *Communications of the ACM*, *46*(12), 167-177.
7. Duncan, R. (1979). "What is the right organization structure? Decision Tree Analysis Provides the Answer". *Organizational Dynamics*, *7*(3), 59-80.
8. Gallivan, M., Truex, D. P., & Kvasny, L. (2002). "An analysis of the changing demand patterns for information technology professionals". *Proceedings of ACM SIGCPR'02*, pp. 11-24.
9. Gallivan, M. J., Truex, D. P., & Kvasny, L. (2004). "Changing patterns in IT skill sets 1988-2003: a content analysis of classified advertising". *The DATA BASE for Advances in Information Systems*, *35*(3), 64-87.
10. ITAA (2001). "When can you start? Building better information technology skills and careers". Information Technology Association of America, http://www.it-careernet.com/betterskills.htm, [Accessed on August 2, 2005].
11. Lee, S., Koh, S., Yen, D., & Tang, H.-L. (2002). "Perception gaps between IS academics and IS practitioners: an exploratory study". *Information & Management*, *40*(1), 51-61.
12. Lee, C. K. (2005). "Transferability of skills over the ICT career path". *Proceedings of ACM SIGCPR'05*, pp. 85-93.
13. Lee, D. M.S., Trauth, E. M., & Farwell, D. (1995). "Critical skills and requirements of IS professionals: a joint academic/industry investigation". *MIS Quarterly*, *19*(3), 313-340.
14. Lee, P.C.B. (2002). "Changes in skill requirements of information systems professionals in Singapore". *Proceedings of the 35th Hawaii International Conference on System Sciences*, pp. 3307-3315.
15. Litecky, C.R., Arnett, K. P., & Prabhakar, B. (2004). "The paradox of soft skills vs. technical skills in IS hiring". *Journal of Computer Information Systems*, *45*(1), 69-76.

16. Medlin, B. D. (2004). "Skills crucial to the information technology professionals in the global business environment: an empirical study in the United States". *International Journal of Human Resources Development and Management, 4*(2), 183-199.
17. Medlin, D. B., Dave, D. & Vannoy, S (2001). "Student views of the importance of technical and non-technical skills for successful IT professionals". *Journal of Computer Information Systems, 42*(1), 65-69.
18. Moore, F. L. & Streib, J. T. (1989), "Identifying the gaps between education and training". *Proceedings of the Twentieth SIGCSE Technical Symposium on Computer Science Education*, pp. 52-55.
19. Ng Tye, E. M. W., Poon, R. S. K., & Burn, J. M. (1995). "Information systems skills: achieving alignment between the curriculum and the needs of the IS professionals". *ACM DATA BASE Advances, 26*(4), 47-61.
20. Niederman, F. (2004). "IT employment prospects in 2004: A mixed bag". *Computer, 37*(1), 69-77.
21. Petersen, A. W. & Wehmeyer, C. (2004). "European qualification strategies in information and communications technologies (ICT) – towards a European (reference) ICT skills and qualification framework". *Proceedings of ICCC'04*, pp. 35-43.
22. Petrova, K. & Claxton, G. (2005). "Building student skills and capabilities in information technology and eBusiness: A moving target". *Journal of Information Systems Education, 16*(1), 27-43.
23. Pick, J. B., Mallen, G., Navarrette, C., Guthrie, R., & Valle, L. (1998). "Cross cultural comparison of the concordance of IS education/training and IS careers in the United States and Latin America (panel)". *Proceedings of ACM SIGCPR'98*, pp. 108-109.
24. Reisman, S. (2005, May-June). "Quality IT education strikes out". *IT Professional,* 16-17.
25. Segars, A. H. & Hendrickson, A. R (2000). "Value, knowledge, and the human equation: Evolutions of the information technology function in modern organizations". *Journal of Labor Research, 21*(3), 431-445.
26. Shackelford, R., Cassel, L, Cross, J., Davies, J., Impagliazzo, J., Kamali, R., Lawson, E., LeBlanc, R., McGettrick, A., Sloan, R., Topi, H., & van Veen, M. (2004), "A guide to undergraduate degree programs in computing (Strawman Draft)". Joint Task Force for Computing Curricula 2004, http://www.acm.org/education/, [Accessed on June 13, 2004].
27. Tang, H-L., Lee, S., & Koh, S. (2001). "Educational gaps as perceived by IS educators: A survey of knowledge and skill requirements". *Journal of Computer Information Systems, 41*(2), 76-81.
28. Von Hellens, L. & Nielsen, S. (2001). "Australian women in IT0". *Communications of the ACM, 41*(7), 46-52.
29. Wade, M. & Parent, M. (2002). "Relationships between job skills and performance: a study of webmasters". *Journal of Management Information Systems, 18*(3), 71-96.
30. Weber, J. E., McIntyre, V. J., & Schmidt, M. (2001). "Explaining IS Student and IS Industry Differences in Perceptions of Skill Importance". *Journal of Computer Information Systems, 41*(4), 79-82.
31. West, L. A. & Bogumil, W. A. (2001). "Immigration and the global IT work force." *Communications of the ACM, 44*(7), 34-38.
32. Williams, J. (2004, November-December). "IT Education: more specialised in 2010". *IT Professional,* 18-20.
33. Yen, D. C., Chen, K., Lee, S., & Koh, S. (2003). "Differences in perceptions of IS knowledge and skills between academia and industry: findings from Taiwan." *International Journal of Information Management, 23*(16), 507- 522.