Knowledge/Skill Requirements and Professional Development of IS/IT Workers: A Summary of Empirical Findings from Two Studies*

by

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Background

Over the last eight years, I have been involved in a series of studies that examine the knowledge requirements and professional development of young information systems/information technology (IS/IT) workers. (e.g., Lee, 1999; 1998; Lee, Trauth, and Farwell, 1995; Trauth, Farwell and Lee, 1993) This work builds upon previous research I have been pursuing for twenty years on the key factors that determine the long-term job performance of young technological workers (e.g., Lee, 1994; 1992). I would like to share the empirical results that could shed light on some of the complex issues regarding the effective development of human resources in IS/IT.

The comments and results that I present today are based primarily on two multi-year, empirical research projects:

1. Findings from a completed, three-year study sponsored by the Boston Chapter of the Society for Information Management (Boston SIM): This study was initiated in response to expressed concerns by industry executives to investigate anticipated changes in the skills and knowledge requirements of the IS/IT profession, and to relate these requirements to the academic preparation of future IS/IT workers (c.f. Lee, Trauth, and Farwell, 1995). I co-chaired a joint industry/academic task force to conduct the investigation. The formal study included open discussion forums, focus group meetings, and mailed surveys which collected data from five stakeholder groups: i.e., IS/IT managers, (business) user managers, IS/IT consultants, university faculty, and recent university graduates working in IS/IT.

2. Preliminary findings from a current research project that investigates how young IS/IT workers acquire the knowledge they need in industry (Lee, 1998; 1999): This study is supported by an exploratory research grant from the National Science Foundation, and we have just completed data collection from four groups of study participants, including a) about 300 college graduates who have been hired by a national IS consulting firm over the last two years; b) new members of the Association of the Computing Machinery (ACM) professional society who have recently changed from a student to a full membership; c) alumni of one of the largest computer information systems departments at a School of Management in the northeastern U.S., and d) alumni of a well-established School of Information Science in the northeastern U.S. These four samples cover a broad spectrum of recent university graduates who work in the IS/IT field, ranging from liberal arts undergraduate majors (among the new hires in the consulting firm) to new Ph.D.s in computer science or engineering from research universities (in the ACM sample). The study examines these IS/IT workers' daily task activities, information seeking and knowledge acquisition behaviors.

Research Focus

The focus of my research is on the skills/knowledge required for IS/IT workers and the means through which they acquire the information they need. There are several major reasons why this focus is crucial for investigating the effective development of IS/IT human resources:

1. The essence of technological work is knowledge and information flow. There is a long tradition of empirical research in this area that has helped us understand the universal nature of the knowledge system in science versus the organizational nature of the knowledge system in technology (e.g., Allen, 1977). However, relatively little is known about the knowledge system in IS/IT. While some aspects of IS/IT work require state-of-the-art technical knowledge, other aspects require organizational knowledge. A clear understanding of the knowledge requirements and information flow in IS/IT is thus central in providing us with insight about the nature of the different types of IS/IT work and the key factors that can affect task performance, human resource development and work productivity.

2. Few occupations in human history have faced such rapid changes in their knowledge base and work requirements as the field of IS/IT today. These changes are driven not just by the unprecedented amount of new technical knowledge in the field of computing and telecommunications, but also by the changing business and social-technological requirements (e.g., Farwell et. al., 1993). A central question for the development of effective IS/IT human resources is thus how they can keep up with the relevant changes in knowledge and information requirements.

3. Previous research studies have found that one of the most important factors that affect the job performance of young technological workers is how they seek the information they need for their work (e.g., Lee, 1989; 1996). There is also a large amount of empirical evidence that has shown the early work experience of young technological workers is important in determining their long-term work job performance (c.f., Lee, 1996). Thus, research about how young IS/IT workers acquire the knowledge and information they need for their tasks can provide important insights into the development of an effective work force in the future.

4. The great demand for IS/IT workers has opened up tremendous career opportunities for women, minorities and new immigrants. For example, over the last decade, IS/IT has emerged as the largest technical occupation where women have now become a significant part of the work force (SESTAT 1993 - 1997). An understanding of how women and other minorities make the transition into this occupation and acquire the knowledge they need for different types of IS/IT work is vital in promoting an effective and diverse work force of the nation.

Summary of Major Findings

I. Skills/Knowledge Requirements

    A. Summary:

    IS/IT work covers a diverse range of task activities with rapidly changing knowledge and skill requirements in many areas. These changing job requirements are caused not just by rapid technological developments, but also by fast changing business and social needs; e.g., reengineering, restructuring, enterprise integration, Y2K, electronic commerce, etc. Thus, the

requisite skills/knowledge sets are not just technological, but also managerial and organizational.

B. Specific Empirical Findings:

In our research, we have grouped skills/knowledge sets into four broad categories: 1) Specific Technical-Specialties Knowledge, 2) Technology Management Knowledge, 3) Business Functional Knowledge, and 4) Interpersonal and Communication Skills (c.f., Lee, Trauth and Farwell, 1995). Interestingly, our respondents across all samples consistently rated Interpersonal/Communication Skills and Business Functional Knowledge as more important requirements for their current job than Technical-Specialties Knowledge or Technology Management Knowledge. This includes even the recent Ph.D.s who are engaging in R&D work in IS/IT.

The evolving computing infrastructure in organizations (e.g., from centralized computing to client/server computing, intranet and extranet networks with the accompanying business process transformations) has also led to significant and constant shifts in the portfolio of knowledge/skill sets required for IS/IT workers in organizations. Moreover, the requirements for IS/IT knowledge and skills are becoming more demanding along the multiple dimensions of technology, management and organizational skills (Farwell et. al., 1993; Lee, Trauth and Farwell, 1995).

II. Educational Background of IS/IT workers

A. Summary:

Just as IS/IT work covers a wide range of activities, IS/IT workers are not all alike. They come from a variety of educational backgrounds and they might also have various prior work experiences. We should not equate IS/IT work strictly with academic disciplines and majors at universities. The evolving information economy requires workers who understand not just technology, but also many areas of specific business and social needs in order to transform our society in the internet age.

B. Specific Empirical Findings:

For example, among a group of 300 new college graduates hired by a large, national information systems consulting firm over the last two years, only about 9% majored in computer science or computer engineering; another 9% majored in MIS/IS in business or management programs. The rest all majored in non-computer related areas. Conversely, out of a group of about 125 new members of the professional society of the Association of Computing Machinery contacted (about two-thirds of them with a master's degree and one-third with a doctoral degree, mostly in computer science or engineering), 30% indicated that they are *not* working in the IS/IT field currently (Lee, 1999).

III. Linkage Between Academic Preparation and Industrial Needs

A. Summary:

Is there a "gap" between the academic preparation offered by universities and what industry really demands? The answer is yes – but we should be careful in drawing conclusions (Trauth, Farwell, and Lee, 1993). Some of the gaps are unnecessary and there is definite room for universities to improve their curricula to better prepare our future workers, but universities and industry have different roles in our society. Most importantly, education is different from training. Academic programs should stress fundamental concepts, but incorporate more team projects that emphasize information searching and problem formulation (as opposed to problem solving alone) so that students can deal more effectively with the challenges of industrial work (Lee, 1989). Industry needs to assess more carefully the design and effectiveness of its training programs. Universities and industry can also cooperate effectively for mutual benefits.

B. Specific Findings:

On the academic side, some required courses in many IS/IT curricula have little relevance for the overwhelming majority of IS/IT workers in industry (e.g., Trauth, Farwell, and Lee, 1993). Many course offerings are biased by individual faculty member's interests rather than curriculum needs.

On the industrial training side, many of the courses set up by companies have received low ratings from the participants. The most effective courses tend to be those taught by an organization's in-house staff. But companies seem to rely more heavily on courses taught by outside consultants even when the evaluations on these courses are low. In addition, the limited, preliminary data obtained about distance learning courses have shown very low ratings. While some organizations have carefully planned out their training and professional development programs, many others seem to approach them without any systematic assessment.

Young IS/IT workers' assessment of their educational and training courses are also influenced by the stage of their professional development. Just prior to graduation and during the initial couple of years of their industrial work, IS/IT students or workers desire more "practical" courses on the latest programming languages or "hands-on" courses on hardware and networks. However, later on they also criticize many training courses in industry as lacking in concepts that would help them to better understand the technology. There is ample room for university and industry to work together to balance the needs of education and training.

IV. Work-Based Learning

A. Summary:

Because of the blistering rate of changes in technology and business requirements, IS/IT workers must be able to "learn on the job" to function effectively. Thus, it is important to understand how IS/IT workers rely on various means to acquire the knowledge they need for their work (Lee, 1998). Results of our empirical research suggest that IS/IT workers tend to draw heavily from a "bipolar" knowledge structure; i.e., some aspects of IS/IT work require the most current technical knowledge which needs to come from external, state-of-the-art sources; other aspects of IS/IT work tend to be very localized and project team-centric. However, the evidence also suggests that IS/IT workers are not very effective in drawing upon the organization's internal knowledge base outside the project team. As decades of research findings have shown, interaction between IS/IT workers and users remains weak, and this is a major barrier to improving IS/IT productivity. Organizations should take a closer examination at how they can support more effectively the information searching and knowledge sharing needs of the IS/IT workers.

B. Specific Findings:

Interpersonal communication accounts for the most important means of knowledge transfer in technological work. For the IS/IT workers, the most utilized interpersonal information source is the group/team. Information obtained from the team members is also considered significantly more useful than information obtained from any other sources. The two other most relied upon interpersonal information sources are 1) the supervisor/manager and 2) other IS/IT colleagues outside the team. Together with team members, these three interpersonal information sources are considered significantly more useful than the information obtained from any other interpersonal sources. At the same time, interaction with users and clients remains weak for IS/IT workers.

IS/IT workers also rely upon a variety of written and electronic sources for information, including 1) books and references, 2) documentation and manuals, 3) various on-line sources, and 4) the internet. However, both research journals and trade magazines appear to have little impact as important information sources, even for the more technically oriented IS/IT workers involved in industrial R&D work.

The intranet, which has been considered a most important source of organizational knowledge base for many IS/IT workers, does not seem to meet its potential in spite of the large amount of resources many organizations have invested to promote its usage. In sharp contrast, the internet/WWW is emerging to be a far more important source of information for IS workers. The preliminary evidence is that IS/IT workers use it frequently to obtain very useful information for their work (Lee, 1999).

V. Organizational Support, Job Performance, and Human Resource Development

A. Summary:

Research evidence over the past several decades suggests that the initial work experience of young technological workers might play an even more important role than education in determining their long-term job performance (Lee, 1989; 1992; 1996). Our current study for IS/IT workers suggest that there are a number of things besides providing formal educational and training that organizations can do to improve their job satisfaction and performance. The key organizational factors that could make a significant difference include: challenging work assignments, job orientation and job-rotation programs, as well as work-based social support provided by the manager, mentor, and team members. Ironically, while many organizations willingly spend large amounts of money to recruit and train new IS/IT workers, few invest in resources to assess and find ways to help their workers develop and function more effectively on the job. This is an important area that researchers and industry practitioners can work productively together.

B. Specific Findings:

The most important factor that motivates IS/IT workers is challenging work that can help them develop professionally. Interestingly, pay or near-term compensation does not appear to be as important a job satisfaction motivator as people might believe. Moreover, so far in our analysis, pay and compensation are not correlated with any job outcomes or other important indicators.

In addition to work assignment considerations, there are a number of organizational factors that can affect the job performance and development of IS/IT workers: For example, orientation programs can be designed more effectively to introduce new workers to the operational aspects of the organization, rather than just to cover the administrative aspects or to facilitate peer socialization amongst the new hires. We also found that managers, mentors, and team members all play significant roles in lending various types of help that are vital to learning and job performance, such as teaching, coaching, motivating, advocating, and information referral, as well as in providing material support and emotional support. Overall, we have found a number of mechanisms that organizations can utilize to more effectively develop its IS/IT human capital assets.

Conclusion

This report highlights some of the key findings on the knowledge requirements of IS/IT work and the knowledge acquisition behaviors of IS/IT workers. It should be emphasized that some of the results presented are based on preliminary findings as the research is still on-going. However, it is hoped that these results serve to shed light on some of the complex issues about the development of an effective IS/IT work force and perhaps challenge some of the common biases. More importantly, I hope it also demonstrates how academic researchers and industry practitioners can cooperate to address some of these complex issues for mutual benefits.

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