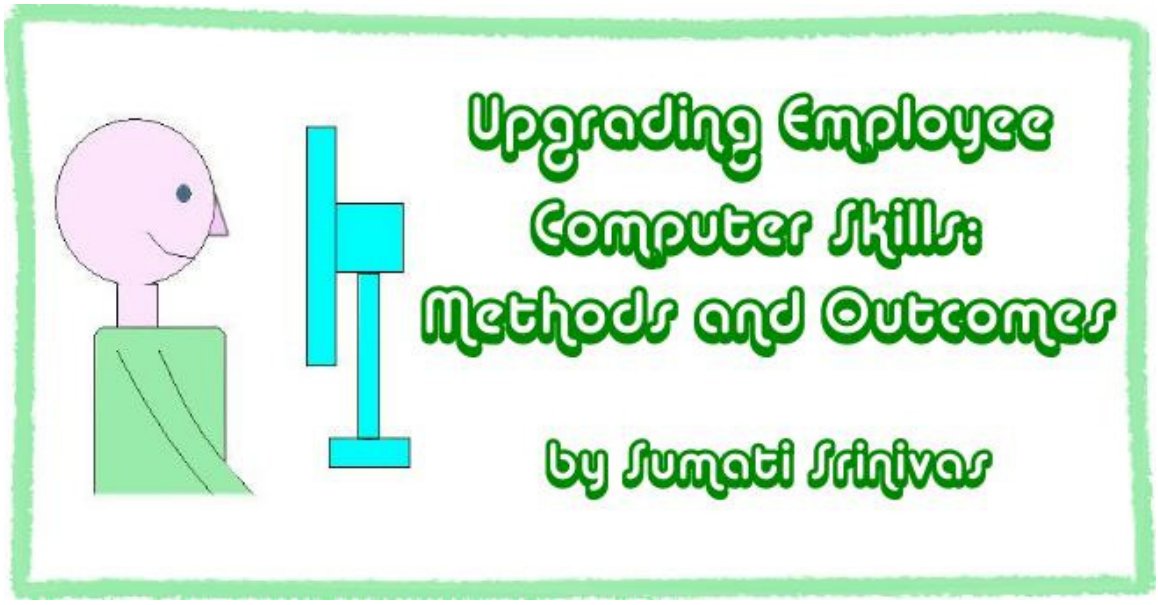

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Peer reviewed

Abstract

Businesses are being constantly faced with the necessity of upgrading their employees' computer skills in order to stay competitive. This need applies across industries and across most occupations within an industry. In this context, designing an optimal computer training method becomes key to a successful transformation of the workplace. This study uses survey data for the years 1993-94 and 2004 from the National Longitudinal Survey of Youth 1979 (NLSY79), to analyze the training methods commonly used to upgrade employee computer skills, with a focus on informal training. Formal classroom training has been better researched because it is more easily measured. However, there is increasing evidence that much of employee skill upgrading actually occurs through informal, on-the-job training. This study provides a comparison of how computer training has changed between 1993-94 and 2004, as well as an analysis of current trends in the nature of both formal and informal training, and post-training job outcomes. Employees who undergo computer training are found to have on average better paid, more stable jobs than those who do not. Moreover, a large segment of the survey respondents used informal training methods such as peer group training and structured self-study to upgrade computer skills. Employees using informal training methods are found to have

higher levels of job satisfaction, promotions, wage increases and job stability post-training. Among informal training methods, self-study methods yielded the greatest post-training benefits in 2004.

Introduction

The rapid rate of computerization in the workplace since the beginning of the microprocessor revolution has seen businesses striving constantly to maintain a computer-literate workforce in an ever-changing workplace. In addition to capital investment in computer equipment and software, businesses have come to realize the competitive advantage stemming from employees with up-to-date computer skills, as has been documented in studies such as Alavi et al (1988). This has resulted in employers placing an increased emphasis on computer training. According to the American Society for Training and Development (ASTD), US companies spent 12 percent of their 1997 training budgets on teaching employees computer skills (McCune, 1999), while during the year 2000 the largest share of firms' training costs went to technical processes, procedures and information technology skills (Van Buren and Erskine, 2002). The US Bureau of Labor Statistics reports that computer skills are among the top three types of job skills most commonly taught through formal training. Formal training alone, however, does not capture the full extent to which employees need to adapt to increasing deployment of computer equipment and software in the workplace. Informal training, in the form of mentoring from supervisors or peers, self-study, learning-by-doing, etc., plays a significant role in most organizations. Surveys such as those by the US Bureau of Labor Statistics (1996) and Barron et al (1997) suggest that informal training may in fact play a larger role than formal, classroom-style training.

There are several informal training methods which are used in the workplace to upgrade employee skills, and awareness of the importance of informal training has been increasing in recent years. Of particular interest is the concept of self-directed learning (SDL), a term that encompasses a variety of methods through which employees upgrade their skills using structured self-study techniques and pace themselves through the training program. Ellinger (2004) provides an up-to-date survey of the concept of SDL and its application to training in the workplace. On-the-job training assisted by peer groups, whether accomplished using group processes such as action learning (Smith and Peters, 1997) or via mentoring programs have also been widely adopted by firms. In their survey of computer users, Lambrecht et al (2004) find that 71 percent report learning their skills through informal on-the-job training, observation or just "picking things up".

Any study of the techniques that businesses can adopt to upgrade their employees' computer skills must, therefore, look at informal workplace learning processes as well. However, research on the outcomes from these informal techniques, especially when applied to learning computer skills, is scarce in the

literature, being mostly limited to case studies of individual firms that cannot be generalized. This is mainly because informal training methods are inherently difficult to measure. As Stern and Sommerlad (1999) state, "we do not have a good picture of how much workplace learning activity is actually going on, or what form it takes…Because informal training and learning is so inextricably linked to the day-to-day operation of the company, it virtually defies quantitative measurement."

This paper attempts to do just that: to quantitatively measure the nature and of informal training methods used to upgrade computer skills in the workplace and the post-training job outcomes of employees who undergo such training. To do this, it takes advantage of two unique sets of questions, one administered during the 1993 and 1994 rounds and the other during the most recent (2004) round of the ongoing National Longitudinal Survey of Youth 1979 (NLSY79). (For more information about the NLSY79 survey, please refer to US Bureau of Labor Statistics (2004).) These two rounds of the survey ask respondents whether they needed to learn new job skills during the past year. If they did, they were given a list of overlapping options characterizing the kind of job skills learned. Although the list of job skills differ between the 1993-94 and 2004 rounds, both surveys ask respondents if they the training was intended to make them “acquire or upgrade computer skills.” Respondents who acquired any new job skills were further asked an extensive set of questions. that document the nature of the process they used to acquire their skills. (A subset of the survey questions used in this study is listed in the Appendix.) In 1993-94, a combined total of 3,206 survey respondents reported acquiring some form of new job skills, of which 2,251 respondents acquired or upgraded computer skills. In 2004, 1078 respondents acquired new job skills through training, of which 442 reported upgrading computer skills. Despite differences in the actual survey questions used in 1993-94 and 2004, there is sufficient similarity, especially with respect to computer training methods, to allow a comparison of methods used to upgrade computer skills between the two survey periods, providing insight into the changes in computer training in the intervening 10 years. Besides, the 2004 survey data is interesting in its own right, offering a compelling snapshot of the nature of computer training today across firms and industries in the United States.

The longitudinal nature of the NLSY79 dataset facilitates following the work history of those employees that were required to upgrade their computer skills, as well as the changes (if any) they experienced in their jobs following their skill upgrade. Both surveys note the type of informal training used by workers to upgrade their computer skills, enabling the measurement of the post-training job outcomes for different methods of adaptation to workplace changes. Using this information, the following key questions are answered in this paper, both individually and comparatively for the 1993-94 and 2004 surveys:

1. Which types of occupations are the most likely to require upgrading of computer skills?
2. What is the work background of workers who need to upgrade their computer skills?
3. What is the most prevalent manner of training, and what are the informal training methods used (peer group mentoring/self-study etc.)? and
4. Which of these methods have the greatest impact on the employee's post-training wages, job satisfaction, job stability and promotion prospects?

Each of the above questions has great practical relevance for businesses trying to improve the computer literacy level of their workforce. By identifying those employees who are most likely to require computer skills and promoting the method that provides the best post-training outcomes, businesses can acquire a computer literate workforce while making optimal use of their training dollars.

This paper is organized as follows: The next section analyzes the recent employment history of those workers who needed to upgrade their computer skills. The subsequent section describes the different training methods used and determines which of these measures have the greatest impact on several different measures of employee job success. The final section summarizes the implications of the study for businesses seeking to upgrade the computer skills of their employees.

Who needs computer training?

Before looking at the ways in which employees upgrade their computer skills, the job characteristics of those respondents who needed to upgrade their computer skills are analyzed for the two survey periods. This is useful because it helps identify the sub-groups of employees who are significantly “at-risk” for skill obsolescence, whether this has changed in the last ten years and on whom employers should focus their training strategies. Employees who acquired computer skills are contrasted with those who acquired other (non-computer based) types of job skills. Doing this draws attention to the factors that make computer users different from users of other equipment or work processes.

Since the need for computer skills clearly varies across occupations, respondents are first grouped by broad occupational categories using the 1980 Census Occupational Classification. The percentage of employees who were required to upgrade their computer skills in each occupation is computed and compared with employees in general. Figure 1 (below) shows the results of this analysis. In this figure, a modified stacked chart is used to visually depict the relative sizes of the different occupational categories, and the changes that occurred during the ten year period. (This type of chart is used throughout this

paper to facilitate comparison between the two survey periods.) The size of the boxes within each column in the chart indicates the relative percentage of employees within the category corresponding to that color, while the lines connecting the columns give a visual representation of whether that category has expanded or contracted between columns (diverging lines indicate an expansion, converging lines a contraction and parallel lines indicate that the size of the category stayed the same). To illustrate, the relative percentage of technical workers among those who underwent computer training in 2004 is less than the corresponding figure for 1993-94, as indicated by the converging lines connecting the corresponding boxes in the two columns.

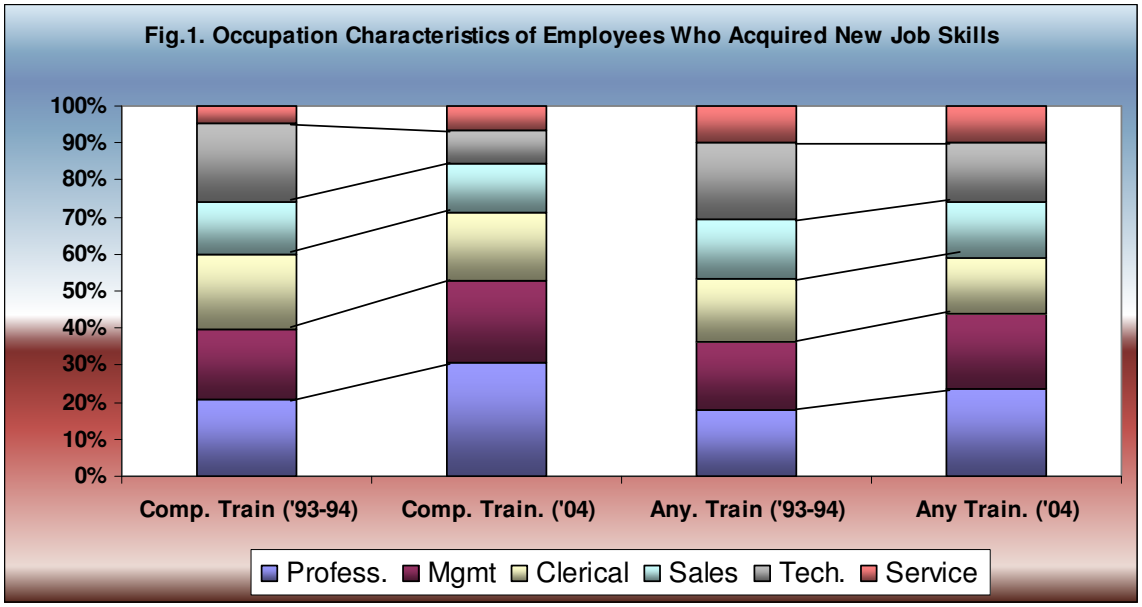


Figure 1 indicates that in both time periods, management and professional workers were the most in need of computer skills upgrading, with professional workers registering a marked increase in training levels in 2004. Equally remarkable is the decline in the share of clerical employees and technicians among those who underwent computer training. This could be due to the fact that computer skills are much more ubiquitous in 2004, and computer training is now needed more for users of specialized software (such as managers and professionals) than for clerical workers and technicians. Also noteworthy is the fact that this change in occupational training needs is specific to computer training, since it is not reflected in the training trends for training in general (as depicted by the label “Any Train.” in the chart).

The longitudinal nature of the dataset makes it possible to look at the recent work history of those employees who needed to acquire or upgrade their computer skills. Of particular interest is the question of whether computer users tend to belong to a more highly-paid, stable class of employees. To examine this

aspect of computer users, labor force status - the number of weeks each respondent spent employed, unemployed, or out of the labor force in the three years preceding the survey - is examined. Figure 2 (below) illustrates the labor force status of those workers who upgraded their computer skills relative to all workers. As the figure shows, workers who upgraded their computer skills spent less time unemployed or out of the labor force relative to all workers for both survey periods. Although employees in both categories reported being out of the labor force longer during the 2004 survey than the 1993-94 survey (most likely reflecting different macroeconomic conditions), workers who underwent computer training spent about 8 percent more time employed than the average worker in 2004.

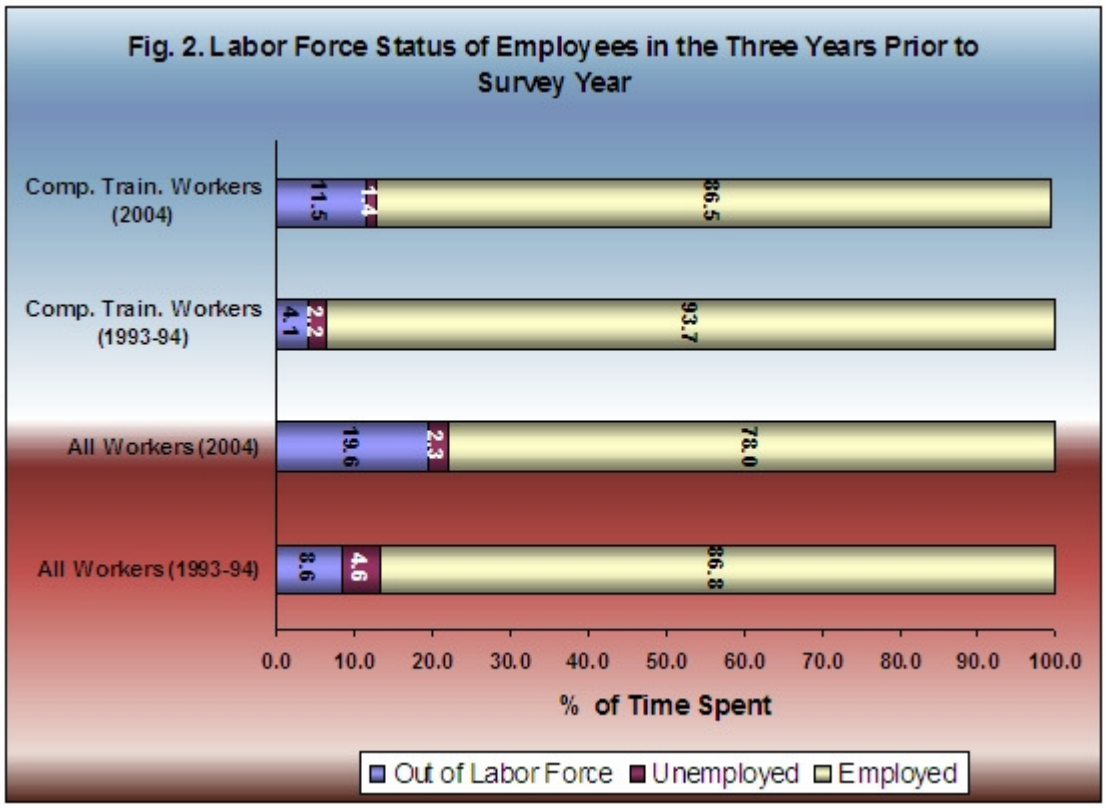
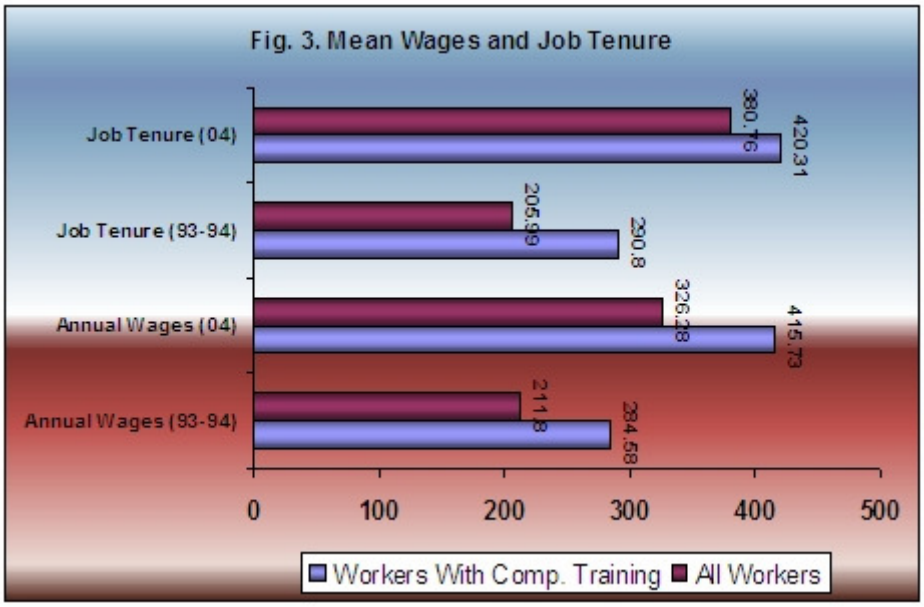


Figure 3 (below) compares the annual average wages and job tenure of workers who upgraded their computer skills with those of all workers in the sample population. Wages are shown in hundreds of dollars to facilitate comparison, and job tenure is defined as the number of weeks the employee has worked at his or her current job. Figure 3 shows that employees who upgraded their computer skills earned an average of $7,280 and $8,945 more than workers who did not in 1993-94 and 2004, respectively. In addition, for the 1993-94 survey period, they were at their jobs for an average of 90 weeks more than workers who did not, which is almost 45 percent larger than the mean job tenure in our sample. This effect is also present, albeit on a reduced scale, in 2004 with

the difference down to an average of 39 weeks. Altogether, these statistics suggest that, in both the 1993-94 and 2004 periods, employers tend to upgrade the computer skills of employees with more stable, better paid jobs.



In order to firmly focus on occupational and job characteristics, areas where the existing literature is lacking, this study does not delineate the demographic makeup of employees who upgrade their computer skills. Readers interested in the demographic aspects of computer skills are referred to the seminal work by Borghans and ter Weel (2002) using British data. Of particular interest is their finding that, contrary to popular belief, age is not a significant factor in determining computer use in the workplace.

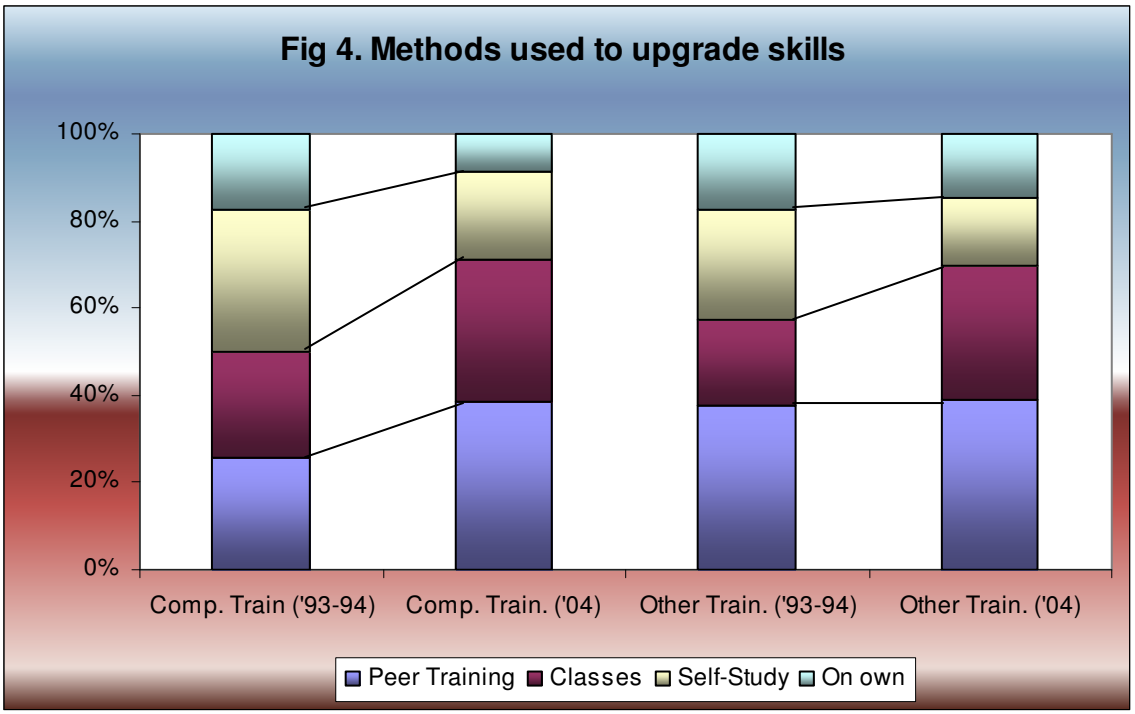
What were the methods used to upgrade computer skills?

Studies of computer training methods have traditionally focused on formal, classroom-based instruction. And indeed, training related to jobs that require sophisticated computer programming skills might best be accomplished via classroom instruction. However, as Jacobs and Jones (1995) extensively document, there is an increasing awareness that informal, on-the-job training might be a better method of teaching employees new job skills. Specifically, Bates et al (2000) provide evidence that supervisory and peer support variables increase the effectiveness of training programs. However, there is very little prior research done into the application of these informal training methods to computer skill training programs. In one of the few studies done in this area, Fitzgerald and Cater-Steel (1995) describe an innovative computer training program where high-quality, cost-effective training was imparted using a peer-educator system. Another area of informal training that is gaining attention is self-paced training

using structured self-study programs. Various self-directed learning models have been gaining popularity in recent training literature, as summarized by Ellinger (2004), and with the availability of sophisticated computer-aided self-learning tools, this would indeed appear to be an effective way to train computer users. There is, therefore, reason to believe that a combination of formal and informal training methods would work especially well for computer training.

The NLSY79 data, by allowing respondents to select from multiple training methods used to upgrade computer skills, provides a unique insight into how formal and informal training techniques coexist in the workplace, and the relative frequency of their use. To facilitate comparison between 1993-94 and 2004 studies, we drop survey respondents who reported being trained by their supervisor in 1993-94, since this option was not provided in 2004. Besides, employees who were trained by their supervisors may have higher wage increases because their supervisor is better able to observe their skill level, and not because of the superior nature of this training method, rendering it difficult to quantify the impact of this method on the job success measures in the next section. This leaves four options for computer training for use in both survey periods : formal classes or seminars, learning with coworkers in a peer training environment, using structured self-study programs, and learning the skills on their own. It is important to note that "self-study" in this analysis refers to employees who used a structured self-study program with the help of course material, computer-aided instruction, etc. Employees who reported acquiring skills "on their own", possibly by using learning-by-doing, are classified as "Others/ on own." In 2004, employees who reported upgrading computer skills but did not specify a method are classified as having acquired them "on their own".

Figure 4 (below) illustrates the percentage of employees who used various training methods to acquire computer skills as compared to other job-related skills. The most common method of learning computer skills in 1993-94 was through self-study material, whereas by 2004 peer group training has become the most popular method. For other (non-computer) job training, peer group training was already the most common method in 1993-94, and it remains very important, though in 2004 formal classroom training had a large increase in popularity. The use of self-study material for computer training has fallen (57 percent to 32 percent) from 1993-94 to 2004 just as the use of peer training has increased (45 percent to 61 percent) Also, employees who upgraded their computer skills reported using a combination of more than one method much more frequently than they did for other skills.



How do employees fare after they upgrade their computer skills?

The best way to determine the success of the computer training methodology would, of course, be to directly measure the increase, if any, in employees' computer skill level after the training. Measuring computer skills directly across occupations, however, is problematic since the definition of what constitutes computer skills varies widely across jobs. Indeed, the most popular definitions of computer skills in the literature, such as those of Gattiker (1992) for instance, define them as a combination of learned and cognitive processes. Such a complex skill would be hard to accurately measure across diverse jobs and occupations. In addition, the measures that have most widely been used in recent computer training literature focus on the immediate post-training phase. A more interesting question, which lies largely unexplored, is that of how employees fare in the longer term in a workplace changed by increasing use of technology. As noted by Compeau et al (1995), managers are more interested in whether the training has transferred itself to the workplace in the long term.

In order to take advantage of the longitudinal nature of the study and given the fact that all members of the sample who acquired or upgraded computer skills admitted that their workplace was changing, it would seem appropriate to take their relative success at their jobs in the year following the skill upgrade as a measure of how well they adapted to those changes. It was possible to do this for both the 1993-94 and 2004 surveys since the exact training date is reported,; thereby allowing the use of only those respondents whose post-training job data is available for at least a year. Such a measure would serve to gauge the post-

training job outcomes of the training method that was used to upgrade their computer skills. Four measures are used to analyze employee job achievements:

1. The percentage change in wages a year after training (1993-94 and 2004 surveys);
2. Whether those who suffered job loss quit their jobs or experienced involuntary job loss during their next two years (1993-94 survey);
3. Whether they were promoted within the next year (2004 survey);
4. The percentage of workers who reported being highly satisfied with their jobs a year after the training (1993-94 and 2004 surveys).

Figures 5 through 8 (below) show the relative percentages of workers evaluated according to each of the above four criteria for each training method used to upgrade computer skills. Figure 5 shows the percentage increase in wages over the previous year; Figure 6 uses data from the 1993-94 survey to compare the percentage of employees who quit their jobs within the next two years and the percentage of those who suffered an involuntary job loss (such as a layoff or firing); Figure 7 shows the job satisfaction as measured by the percentage of employees who reported that they "liked their jobs very much" (The actual question is listed in the Appendix.); and Figure 8 shows the percentage the respondents of the 2004 survey who reported being promoted in the year after computer training. A striking result of these analyses is the relative success of workers who underwent peer group training or used self-study material. The wage increases for workers using self-study material, in particular, have grown dramatically from 1993-94 to 2004, as is shown in Figure 5. And, despite the fact that more employers were arranging formal computer training programs in 2004 (as shown in the last section), the returns to formal classroom training have fallen between 1993-94 and 2004 by almost every measure used here.

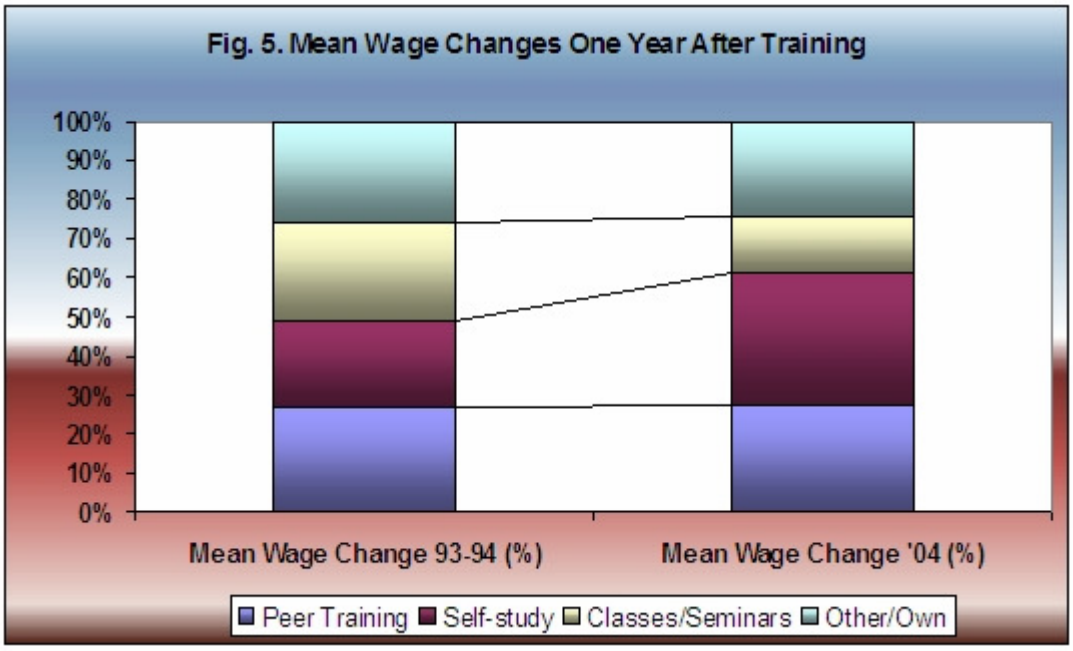


Fig. 5. Mean Wage Changes One Year After Training
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Mean Wage Change 93-94 (%)
Mean Wage Change '04 (%)
Peer Training
Self-study
Classes/Seminars
Other/Own

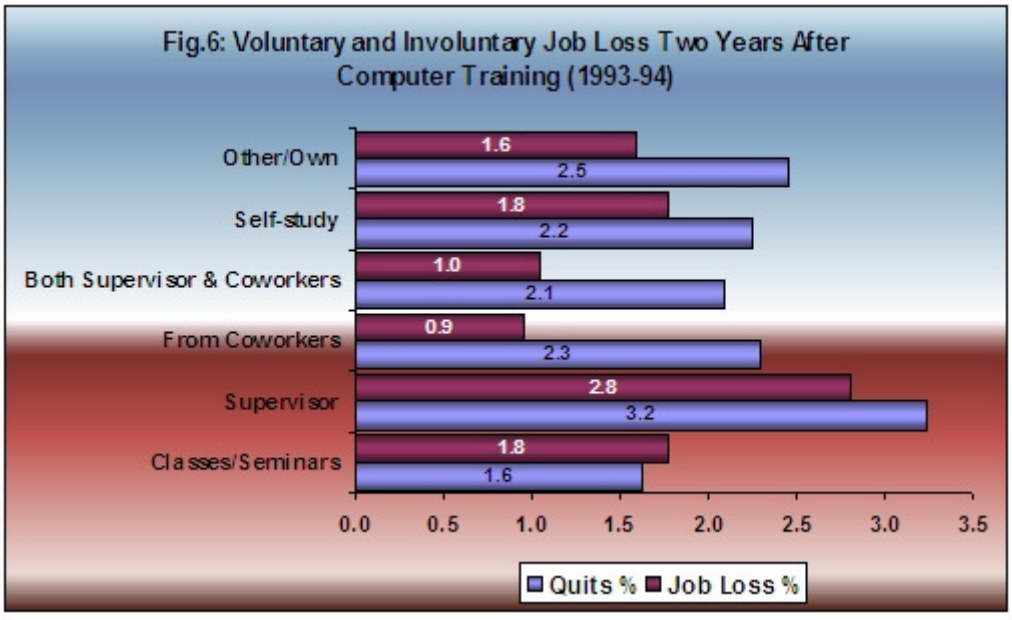
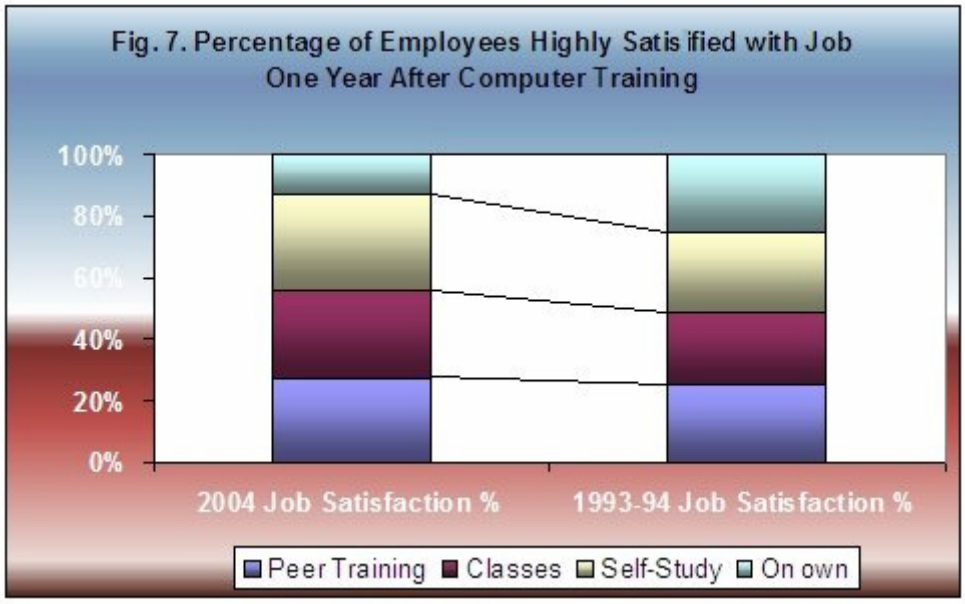
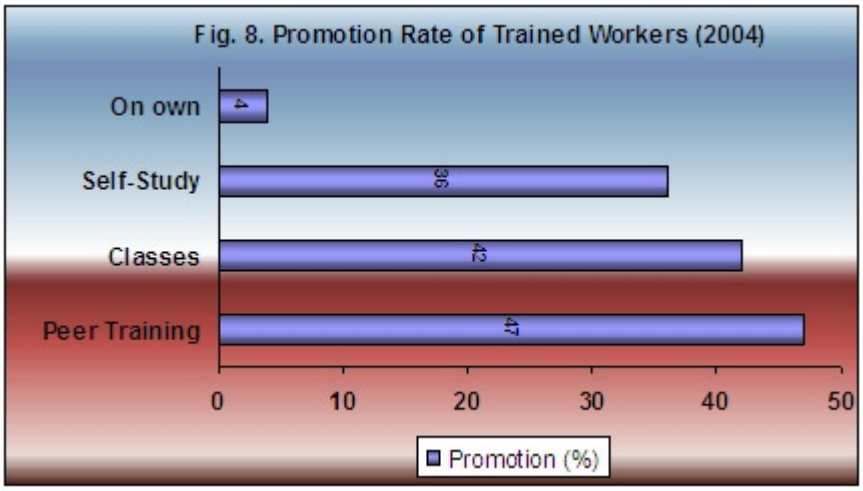


Fig.6: Voluntary and Involuntary Job Loss Two Years After Computer Training (1993-94)
Other/Own
1.6
2.5
Self-study
1.8
2.2
Both Supervisor & Coworkers
1.0
2.1
From Coworkers
0.9
2.3
Supervisor
2.8
3.2
Classes/Seminars
1.8
1.6
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Quits %
Job Loss %





Finally, further analysis of the relationship between training methods and employee success is conducted by computing the correlation between the various methods and measures. In doing so, it is not assumed that computer training is the main reason for the job outcomes that is used as measures of employee success. Many sophisticated economic models can be found in the literature that model the job outcome (wage increase, job loss etc.) as dependent on a combination of individual characteristics (such as gender, age, education, etc.) and job characteristics (such as occupation, industry, etc.). It is clear that computer training would form only one among a host of such reasons fort wage increases, quits, promotions, etc. The goal of this analysis, on the other hand, is to find if any of the training methods used significantly impact job outcome. In other words, it is not the absolute value of the coefficients of correlation that is of interest, but in finding out if any of the training methods used influence the job outcome in a statistically significant way.

The results of the analysis are laid out in Table 1 (below) where the training methods that significantly impact a particular job outcome are highlighted for both the 1993-94 and 2004 surveys. As expected, the coefficients of correlation are very small, due to other individual and job-specific variables that are not part of the current analysis. However, some training methods interact with job outcomes in a statistically significant way, as at the 0.05 level of significance. It can be seen from this table that peer group training in 1993-94 is significantly correlated with a lower probability of involuntary job loss. One explanation for this could be that employees who learn job skills in groups may be better team players and hence less likely to be laid off, The most striking statistic in Table 1 is that self-study methods are significantly associated with job satisfaction in both surveys, and the magnitude of the association is noticeably larger in 2004 than it was in 1993-94. Also, employees who used self-study methods are significantly more likely to be promoted within a year, and here the coefficient of this correlation is by far the highest in magnitude of all the correlations in Table 1.

It should be noted that despite the small coefficients of correlation, the large sample size means that self-study techniques are correlated with the promotion of 89 employees. The stark contrast between the job success indicators for employees who use structured self-study methods and those who upgrade their skills on their own also illustrates the necessity for employers to aid self-directed learning with structured programs, rather than assume that employees will just pick up computer skills on their own. Indeed, as can be seen from Table 1, employees who upgrade their skills on their own without a structured program fare the worst of all, being significantly less likely to be promoted or be satisfied with their jobs.

Table 1

Correlation of Computer Training Methods with Job Success Indicators

	Job Success Indicators (1993-94)				Job Success Indicators (2004)		
Training Method	**Wage Increase**	**Lost Job**	**Quit Job**	**Job Satisf.**	**Wage Increase**	**Promotion**	**Job Satisf.**
Classes/Seminars	0.02	0.01	-0.02	0.02	-0.06	0.08	0.04
Peer Training	0.02	-0.06	-0.01	0.02	0.03	0.06	0.02
Self-study	-0.01	-0.04	-0.02	0.04	0.05	0.19	0.10
Own	0.02	-0.03	-0.01	0.02	0.01	-0.10	-0.08

Highlighted items are significant at the 0.05 level

Policy Implications for Employers

The preceding analysis highlights the increasing importance of informal computer training, and it points to interesting trends within different methods of informal training. Taken as a whole, the results presented in this paper provide an interesting narrative about the state of computer training during the 1994-2004 period. At the start of the 1990s, with a growing realization of the importance of a computer-literate workforce, formal training classes were the dominant method of training, and the training itself was directed across many occupational categories with managers, professionals, and clerical/administrative staff all receiving roughly a proportional amount of computer training. However, the results for the 1993-94 survey indicate that peer training methods were among the most successful among both formal and informal training methods. This falls in line with scholarly work that argued that complete organizational reengineering should accompany computerization. This was promoted by Hammer (1990) with the slogan “Don’t Automate, Obliterate.”

Evidence that employers did in fact realize the importance of peer group training of computer skills can be found in the analysis presented above using the 2004 data, where peer training is found to be used much more often than it was in 1993-94. The interesting fact that emerges from the more recent survey is that computer training appears to have become more specialized, and it is used more often to train professionals and managers than administrative staff. While peer training still provides good job outcomes for this new audience, self-study methods show a dramatic rise in their correlation with high job satisfaction levels and promotions on the job. The fascinating aspect of this result is that, though employees using self-study methods appear to be more successful, the proportion of workers using self-study techniques has actually declined between the two surveys. This finding could be explained in two ways: one is that employees who use self-directed learning methods are more motivated and able; thereby explaining their high job satisfaction and promotion levels. The other is that employers still rely heavily on formal training methods, or peer-assisted learning programs which do not work as well with the highly-skilled professional and managerial employees who have come to constitute the majority of those who undergo computer training. Future research could examine these two factors to determine which one more fully explains the reasons for the increasing success of self-study method. Either way, however, this result emphasizes that employers need to focus more on self-directed learning programs for their employees when they need to upgrade computer competency. Another interesting question for future research is the impact that the technologically advanced techniques that are increasingly available for self-study, such as online learning applications, have had on the observed success of this training method. The results presented here would suggest that employers would reap better

returns from investing in such self-training packages, rather than formal, classroom-based training.

Appendix : Selected NLSY79 Survey Questions

Questions Regarding Job Skills Acquired Due to Workplace Changes in 1993-94

Have any of these changes required YOU to learn new job skills IN THE PAST 12 MONTHS?
Your employer introduced a new product or service.
YES
NO

Your employer introduced new equipment and/or repair procedures.
YES
NO

Your employer needed to upgrade employees' basic skills such as math, reading, or writing.
YES
NO

Your employer needed employees to acquire or upgrade their computer skills.
YES
NO

Work teams were created or changed.
YES
NO

Your work site was reorganized in other ways.
YES
NO

Changes have occurred in your employer's policies such as compensation, benefits, pensions, and safety.
YES
NO

New governmental regulations went into effect.
YES
NO

Changes have occurred in the work rules for reasons other than new government regulations.
YES
NO

Questions Regarding Method Used to Acquire/Upgrade Job Skills in 1993-94

As a result of (this/these) changes at work, did you participate in any classes or seminars to learn how the changes would affect how you do your job?

YES
NO

Who explained or showed you how these changes at work would affect how you do your job? Was it your supervisor, your coworker(s) or both?
SUPERVISOR ONLY
COWORKER(S)
BOTH SUPERVISOR AND COWORKER(S)
NEITHER

In learning how (the/these) changes at work would affect how you (do/did) your job, did you make use of any self-study material or self-instructional packages, such as manuals, workbooks, or computer-assisted teaching programs.
YES
NO

Sometimes people learn new skills on their own in order to move up in the company, get a different job, or keep up with their current job. Apart from any training or instruction your employer (has/had) provided in the (the past year/the last year you worked there), have you spent any time learning new skills on your own?
YES
NO

Questions Regarding Job Skills Acquired During Training in 2004

I am going to read a list of skills that people sometimes learn in training programs. Please tell me if you learned any of the following skills at this training. In this training program, did you learn to...

....learn about a new product or service of the company?

YES
NO

....operate or repair equipment?

YES
NO

....improve reading, writing or math skills?

YES
NO

....acquire or upgrade computer skills?
YES
NO

....learn to be a better supervisor/manager?

YES
NO

....learn a wider range of jobs or cross-training?

YES
NO
....learn about health or safety procedures?

YES
NO

Questions Regarding Method Used to Acquire/Upgrade Job Skills in 2004

Was this training program formal company training run by your employer?
YES
NO

Was this training program a seminar you received at your work but was run by someone other than your employer?
YES
NO

In this training program, did you upgrade skills working as a team?
YES
NO

Did you receive any informal on-the-job training by making use of any self-study material or self-instructional packages, such as manuals, workbooks or computer-assisted teaching programs?

YES
NO

Job Satisfaction (both 1993-94 and 2004)

How (do/did) you feel about (the job you have now/your most recent job)?
(Do/Did) you like it very much, like it fairly well, dislike it somewhat, or dislike it very much?
(CODE ONE ONLY.)

LIKE VERY MUCH
LIKE FAIRLY WELL
DISLIKE SOMEWHAT
DISLIKE VERY MUCH

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Note: Partial support for this research was provided by a 2004 Summer Research Grant from the College of Business and Economics at Radford University. The author would like to acknowledge constructive suggestions by the editor and two anonymous referees that materially improved this paper.

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