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An Analysis and Evaluation of Computer-Related Training Techniques

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End-user computing (EUC), the utilization of computers by knowledge workers without the direct intervention of professional systems analysts and programmers (Davis and Olson 1985), has grown rapidly over the last decade. Surveys of management information systems (MIS) professionals, academics, and general managers indicate that EUC is one of the most important issues facing the information systems organization (Dickson et al 1984, Hartog and Herbert 1986, Brancheau and Wetherbe 1987, Caudle et al 1991). Rockart and Flannery (1983) estimated that EUC accounted for 50% of computing resources in some firms, with that figure rising to over 75% during the 1990s (Benjamin 1982). Given the growing importance of EUC, information system managers need to insure that users acquire computing skills in the most effective and efficient ways possible. One way to achieve this goal is through the use of training programs (Davis and Davis 1990, Harrison and Rainer 1992, Davis and Bostrom 1993, Santhanam and Sein 1994). Training end-users to utilize software tools and to build their own applications has been identified as a critical factor and the most effective mechanism for ensuring the success of end-user computing (Zmud and Lind 1985, Dickson et al 1984, Hartog and Herbert 1986). Harrison and Rainer (1992) found that training is an important factor in removing negative end user computing attitudes. Cheney et al (1986) link the availablity of end-user training programs to the success of end-user computing satisafction. Although a number of training approaches are used in practice (Wolman 1986), the MIS literature provides little guidance for designing effective end-user training. Recently published estimates indicate that more than 100 billion dollars is spent annually on training and development programs of all kinds (Kelly 1982). It is also estimated that only 10 percent of the dollars spent on training results in actual behavioral change back on trainees' jobs (Georgenson 1982).

Trainability refers to a person's ability to acquire the skills, knowledge, or behavior necessary to perform a job at a given level and to achieve these outcomes in the allotted time (Roberts and Downs 1979). The MIS literature has identified training as a critical factor in the success of decision support systems (Fuerst et al 1982, Sanders and Countney 1985), strategic innovation (Kotter and Schlesinger 1979, Kim and Lee 1991), and implementation (Bronsema and Keen 1983, Nelson and Cheney 1987, Grover and Teng 1994). A number of IS training studies have been reported which have improved our understanding of the subject. For instance, Davis and Bostrom (1993) explored training based on different user-computer interface, Olfman and Mandviwalla (1994) ascertained that graphic user interface (GUI) training provided insights into multiple information types, and Santhanam and Sein (1994) found that performance can be enhanced through training methods that provide good conceptual model.

The objective of this study is to furnish a more complete understanding of which training methods provide the trainee with the optimal learning situation. The study draws heavily from the education psychology and management training literature which is anchored in the Lewin Experimental Learning Model (Lewin 1951) and the Kolb Learning Model (Kolb 1984). These models view the learning process as a continuous loop. Two aspects of this learning model are particularly noteworthy. The first is the emphasis on the *here-and-now concrete experience* to validate and test abstract concepts. The focal point for learning is immediate personal experience, which contributes real-life meanings and texture to abstract concepts while at the same time providing concrete, publicly shared reference points for testing the implications and ideas created during the learning process. The second emphasis, action research and laboratory training, is based on *feedback processes* . This information feedback provides the basis for the continuous process of goal-directed action and evaluation of consequences of that action. It is that feedback loop which Lewin believed could eliminate ineffectiveness in the organization.

The study investigates three learning/training techniques plus an unaided-learning, control group in the context of a field experiment. Learning is described as a process whereby concepts are derived from and continuously modified by experience. The first technique, *Instruction-based* learning has been characterized as the situation when "the entire content of what is to be learned is presented to the learner in final form" (Ausubel 1963, p.16). This method offers a traditional approach that is widely accepted and understood. It is appropriate for almost all training needs and can be very dynamic, since the instructor is present to deal with any questions or problems that may arise and give individual attention as needed (Wehr 1988). Instruction-based learning implies a deductive approach to learning, where learners proceed from general rules to specific examples. It tends to favor a programmed approach which grants individuals very little control over the processes or content of learning (Glaser 1966). Davis and Davis (1990) found that the instruction mode was superior to self-directed independent study. The second technique, *Exploration* learning has been characterized as "a matter of rearranging or transforming evidence in such a way that one is enabled to go beyond the evidence so reassembled to additional new insights" (Bruner 1961, p. 22). Glaser (1966) describes exploration learning as a process by which individuals are granted the freedom to impose their own structures on learning. Exploration may also involve an inductive process through which an individual learns general concepts by starting with specific tasks or examples (Taba 1963). The final method, *behavior modeling,* ***is a combination of the exploration and instruction methods which concentrates on the idea of observing and doing while following a role model. Trainees then imitate the role model's behavior in practice. The technique emphasizes learning points in the instruction mode and modeling, practice, and feedback in the exploration or hands-on mode. This approach is anchored in Lewin's (1951) equation B=f(P,E) (behavior is a function of the person and the environment) and Bandura's (1969) principles of social-learning theory. The***

learning environment is viewed as so important that this method places extreme emphasis on creating environmental conditions believed to maximize the learning potential. Therefore, the classroom atmosphere and mix of instructional components are designed to minimize learning barriers (negative reinforcement, fear of failure, boredom, anxiety) and to create positive affect among individuals (Bretz & Thompsett 1992). In training, behavior modeling provides a set of learning points for each transaction that is used to guide the individual to a specific objective, while attempting to maintain self-esteem. Behavior modeling teaches flexibility, not rigidity. The learning points in a behavior modeling process are simply guidelines to teach alternative responses so that an individual can be more flexible. The objective is to teach new ways of behaving and to broaden an individual's repertoire, not to program or control it (Sorcher & Spence 1982).

An analysis of the effectiveness of each technique was performed based on the results of a field experiment utilizing two hundred subjects in a real-world computer training situation. The field experiment evaluated trainees based on two types of knowledge--procedural and comprehensive--suggested by the education psychology literature and widely encountered in computer-related training. Procedural knowledge tested trainees with "hands-on" near-transfer and far-transfer structured computer tasks. Near-transfer (simple) tasks are similar to procedures covered during training. Far-transfer tasks combine two or more near-transfer tasks and typically require trainees to apply problem-solving skills in order to arrive at a solution. Comprehensive knowledge sought to ascertain the trainees overall understanding of the computer system and its functions. The paper and pencil test is designed in two parts to contrast information types: (1) the trainee's ability to grasp the general concepts of the computer system and (2) the trainee's grasp of the procedural information presented during training.

Analysis of variance (ANOVA) was conducted using the three experimental treatment plus the control group. To further substantiate the existence of the effect, six simultaneous single-degree-of-freedom tests were conducted. Scheffé confidence intervals were used to conduct the specific pairwise tests. Three fundamental assumptions of the ANOVA model were confirmed prior to data analysis. The population of the sample were normally distributed, all scores were independent of each other, and the variance for all groups was confirmed to be nonconstant. The non-traditional technique, behavior modeling, produced statistically superior (a = .01) results when compared to all other training/learning techniques (see Tables 1-4). The study also discovered that trainees receiving "hands-on" training (exploration and behavior modeling) performed better than their counterparts in "non-hands-on" or lecture only. The control group, unaided training group, failed to perform as well as any other training group, suggesting the successful design of the study and the importance of end-user training.

The results of the field experiment indicate that the use of hands-on training methodologies and in particular, the behavior modeling technique led to more effective utilization of training resources. The introduction of the behavior modeling technique also has implications for end-use satisfaction and the creation of incentives to increase system use.

References available upon request.

Table 1 Near-transfer scores by treatment group
(Maximum possible: 24 points)

Group	Mean	Standard Deviation	
Control	0.00	0.00	Significantly different ($F_{4.195}$ = 826.0, p = 0.000)
Instruction	3.92	3.72	
Exploration	20.96	3.31	
Behavior Modeling	23.71	0.98	

Table 2. Far-transfer scores by treatment group
(Maximum possible: 6 points)

Group	Mean	Standard Deviation	
Control	0.00	0.00	Significanly different ($F_{4.195}$ = 161.3, p = 0.000)
Instruction	0.63	1.22	
Exploration	3.58	1.89	
Behavior Modeling	5.50	1.12	

Table 3. Procedural Comprehension scores by treatment group
(Maximum possible: 70 points)

Group	Mean	Standard Deviation	
Control	0.92	2.45	Significantly different ($F_{4.195}$ = 167.7, p = 0.000)
Instruction	14.04	12.92	
Exploration	36.88	14.75	

Behavior Modeling	51.92	11.81	

Table 4. General Comprehension scores by treatment group
(Maximum possible: 55 points)

Group	Mean	Standard Deviation	
Control	20.00	10.61	Significanly different ($F_{4,195}$ = 48.35, p = 0.000)
Instruction	32.29	12.23	
Exploration	34.79	12.87	
Behavior Modeling	49.00	5.16	