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Cognitive Elements in the Implementation of New Technology: Can Less Information Provide More Benefits?

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Introduction

Organizations have come to rely on technological innovation as a central component of their

competitive strategy (Reddy, 1990). While new technologies hold tremendous promise for enhancing organizations' efficiency and effectiveness, much of this potential is never realized (e.g., Kwon and Zmud, 1987). One study of 2,000 U.S. companies found that 40 percent had not achieved the intended benefits from implementing an office technology (Bikson and Gutek, 1984). Significantly, less than 10 percent of these implementation failures appeared to stem from technical problems; most occurred for human and organizational reasons, such as poor technology management (Bikson and Gutek, 1984), including users' misunderstanding of the meaning and/or uses of the technology (e.g., Griffith, 1993).

Griffith and Northcraft (1993) have proposed a model of the *cognitive* determinants of technology implementation success. Their model emphasizes that differences in cognitions (e.g., thoughts, perceptions, and constructed understandings) among users, designers, and implementers (e.g., Lind and Zmud, 1991) are critical determinants of implementation success. Prior researchers have provided broader models of implementation (e.g., Cooper and Zmud, 1990; Goodman and Griffith, 1991); the Griffith and Northcraft (1993) model focuses on the problematic human and organizational components of technology implementation success.

This paper explores the major mechanisms within the Griffith and Northcraft (1993) cognitive model. This model offers a fine-grained view of how user and implementer understandings influence implementation success. While broader implementation models suggest structural and process strategies for increasing the likelihood of implementation success, this model describes user and implementer understanding and can be used to design appropriate implementation strategies.

The Cognitive Framework

Past research has underemphasized the role of cognitions in implementation, even though cognitions are known to be crucial to the adoption process immediately preceding implementation (Sproull and Hofmeister, 1986). Griffith and

Northcraft (1993) have suggested an important role for implementer cognitive *frames*, in the presentation of information during the implementation of a new technology. Frames are the perceptual sets that direct an individual's critical cognitive processes (e.g., Pinkley, 1991; Pinkley and Northcraft, 1994), including directing what information to attend to and how to interpret that information. Frames invoke selective perception (e.g., Dearborn and Simon, 1958) and thus, influence how users come to understand a new technology in its organizational setting (e.g., Louis, 1980). During implementation, the frames of implementers (those responsible for the introduction of the technology to prospective users) will limit both what information implementers provide to users, as well as influence how implementers interpret users' comments or questions.

There are two types of information that implementers might present to introduce a new technology — descriptive and operational — and either type of information can be positive or negative. Thus, descriptive information refers to the positive and/or negative uses of the technology, i.e., the benefits and costs that can result from the technology's use. Similarly, operational information describes *how* to use (positive operational information) and/or not to use (negative operational information) the technology.

Paradox of positive value

A problem arises when there is a discrepancy between the cognitive frames that implementers bring to implementation — *and consequently the information that implementers present to prospective users* — and users' informational needs (Griffith and Northcraft, 1993). This problem, known as the paradox of positive value (Baier, et al., 1982), occurs when implementers present predominantly positive descriptive information about a technology. Implementers may emphasize positive descriptive information because that is the cognitive frame they bring to implementation — a frame of strong belief in the benefits of the technology. Implementers may unintentionally disregard operational concerns because of their familiari-

ty with the technology; even complex operational issues will have become second nature to implementers and thus, are not salient when implementers present information to prospective users (e.g., Sproull and Hofmeister, 1986). Subconsciously, implementers may emphasize the benefits (positive descriptions) of a technology in order to insure users' initial interest or to rationalize their implementer role (e.g., Festinger, 1958).

Users, in contrast, have a high need to reduce uncertainty (Lester, 1986) and gain control over the technology (Baronas and Louis, 1988; Falcione and Wilson, 1988) during implementation. Appeasing these needs should lead users to want to know more than just the benefits of the technology; users should want an understanding of the operational facets of the technology, as well as an understanding (forewarning) of any negative features. This is the paradox of positive value: By focusing only on the benefits of the technology, implementers seem destined to disappoint users — *not fulfill users' informational needs* — and thus, increase the likelihood of implementation failure (e.g., Sproull and Hofmeister, 1986). It is not that implementers wish to deceive users; implementers, because of the cognitive frame they bring to implementation, simply are unable to adequately empathize with users' information needs.

Paradox of negative experience

The problem presented by the paradox of positive value is that users who are underprepared by a positively biased introduction to a technology will encounter negative surprises (Louis, 1980) — operational difficulties and unanticipated costs — and that these negative surprises doom implementation to failure. Griffith and Northcraft (1993) have suggested, however, that within this problem there is a surprising opportunity — the paradox of negative experience. Users should be discouraged by a technology's negative surprises *only when those surprises are costly*. If the discovery of negative surprises is not costly to users, negative surprises offer opportunities for trial-and-error learning that instill in users the prospect that

there is more to learn. The paradox of positive value is that an implementer's positively biased presentation of a technology makes negative surprises inevitable; the paradox of negative experience is that these negative surprises, if managed well, become valuable *positive* learning experiences for users.

The paradox of negative experience is built on the idea of exploration-based (rather than instruction-based) learning. Exploration-based learning entails providing novices only enough understanding of something (e.g., a new technology) to begin using it and to begin discovering the limitations of that understanding (e.g., Davis and Bostrom, 1993). Implementers provide users with an initial (positively biased) understanding of the technology; users' initial experiences with the technology help users begin to restructure and adapt their understanding of the technology (beyond that provided by the implementer). These steps are related to the concepts of "mapping via training" and "mapping via usage," respectively (Bostrom, et al., 1990, p.103).

There are two important qualifications to the paradox of negative experience. The first is that negative surprises will only be more valuable rather than discouraging *if* they are not personally costly to users. In organizations, users' early experiences with a technology can be thought of as either on-the-job or free (Griffith and Northcraft, 1993). Initial experiences that are on-the-job require users to complete work (and have that work evaluated!) while also learning to use the technology. Under these circumstances, negative surprises will be personally costly to users; users will incur the cost of not finishing the required work or finishing it poorly (and suffering commensurate performance evaluations). The alternative — free training — refers to time off-line provided for users to explore the limits of their understanding of the technology when organizational work is not required or not evaluated. Under these circumstances, the errors of trial-and-error learning can be relatively costless.

Free training also has important implications for user satisfaction. Discrepancy theories of job satisfaction (e.g., Katzell, 1964; Locke, 1976) suggest that negative surprises will cre-

ate user dissatisfaction with the technology. However, this dissatisfaction should be moderated by the costliness of the negative surprises. If negative surprises are encountered during evaluated on-the-job performance, the costs will be greater for users and therefore dissatisfaction with the technology more extreme, than if those negative surprises are encountered during free training.

The second qualification to the paradox of negative experience is that users are most likely to learn when their experiences *disconfirm* the expectations (schema) provided them by implementers (Louis, 1980; Louis and Sutton, 1991). Discovery of discrepancies between expectations and perceived reality pushes users into active thinking, and away from habits of mind (e.g., Louis and Sutton, 1991) where learning does not take place. If implementers provide enough information for users to use the technology without encountering negative surprises (Louis, 1980) during free training, then users may only confirm their expectations (Klayman and Ha, 1987). The more information users have during free training, the less likely that they will learn to adapt in this period where mistakes are relatively costless. Thus, a little failure is not only good but necessary for successful learning and adaptation, as long as it can be made relatively costless (March, 1976). Costly training, (e.g., on-the-job) where individuals do not have time to make mistakes, cannot make mistakes without cost to company, customer, or self, or where mistakes result in embarrassment dramatically limit individuals' opportunities for learning. Instead, users may learn only to avoid mistakes, and so never adapt or explore the technology.

Cognition and implementation: hypotheses

To summarize, users provided with positively biased introductions to a new technology, such as implementers tend to provide (Griffith and Northcraft, 1991), will encounter negative surprises during their initial use of the technology. Implementation success depends on whether those surprises are costly to the user. Costly surprises (in which users' work is lost or not

completed due to problems with the technology) likely will decrease user satisfaction with and interest in the technology. Relatively costless negative surprises, on the other hand, provide users with the knowledge that there is more to learn about the technology, but without damaging the users' reputation or work. Thus, the following hypotheses are examined:

H1: Users provided with information biased toward positive description and no chance for costless discovery will have lower satisfaction with the technology than users provided with either more balanced information (positive and negative operational and descriptive information) or those allowed free training (costless preperformance opportunities to discover the technology).

H2: Users provided with information biased toward positive description but allowed free training will be more successful in their utilization of the technology than users provided with more balanced information or those not allowed a chance for costless discovery.

Users who are provided with and confirm a relatively balanced understanding of the technology (e.g., Klayman and Ha, 1987; Louis, 1980) are likely to conclude that there is little more to learn. If the presentation has truly been realistic and balanced, then this prediction applies to both users provided with free training and those only given on-the-job experience. Users provided with a fuller, balanced spectrum of information should be able to perform the basic tasks taught during implementation, but they will have a shallow understanding of the technology and may be less prepared to adapt for long-run implementation success.

H3: Users provided with balanced information will have lower perceived need to learn than users provided with positively biased information.

Method

Subjects and task

One hundred twenty-nine upper-division university students enrolled in an organizational behavior course volunteered to use a presentation software technology to create presentation materials for assigned group projects. These projects entailed grades for professionalism of presentation, a large component of which was the quality of the presentation materials created. Presentation grades were not a component of the study, and students were not required to use the materials they created with the technology, although they were required to create presentation overhead materials for their group projects by some method. Volunteers received extra course credit for agreeing to learn to use the software.

The context of the study was thus more field than laboratory (Mawinney, 1986). Subjects were members of the organization (the class) that would utilize the product of their work, and this work had to be completed whether or not the study took place. Subjects' use of the technology was directly related to their real world need to complete presentation materials (overhead transparencies) for their projects. As suggested by Campbell (1986), the constructs tested in this research were comparable to those extant in a field setting. Although subjects' participation was relatively brief, parallel tasks in an organizational setting would be similarly limited (e.g., a project team creating a presentation to report on its work). Therefore, the constructs examined here are expected to operate as they would with similar tasks and technologies; differences in effects should be in level rather than direction.

Design

A 2x2 (Balanced/Positive-Only Information by Free-Time Training/On-the-Job Performance) between-subjects design was employed. The information manipulations were provided both within the classroom introduction to the software and during actual use of the software. The

Free-Time Training condition was created by providing subjects with preperformance time to experiment with the software (versus providing only the three hours of on-the-job performance time allocated to create the presentations).

Facility and software

The presentation software was installed on nine 386-level PCs, each located in a separate room. The software provided capabilities for text, drawing, clip-art, and data charts. Pretesting had revealed that only one student in the course was familiar with this particular software package. That student did not participate, so all subjects were new to the software.

Materials and measures

Training materials included a scripted introduction to the software (for use by the two implementers), overhead transparencies explaining the software, and detailed instruction sheets for creating presentation materials using the technology. The introductions, overheads, and instruction sheets provided the Information manipulations. Balanced Information materials included positive and negative statements about the software and operational instructions about what to do and not do using the software. Positive Description-Biased materials provided only the most necessary operational steps to using the software and neither negative comments about the software nor any instructions about what not to do. Each computer room was supplied with the software's summary reference manual and the full reference guide (over 400 pages). Students supplied their own sketches and ideas for their work time. Subjects were provided five sample slides created using the software. These slides were text only and used the default background. These sample slides illustrated the most basic use of the software.

Subjects' utilization of the technology was measured against the basic format provided in the samples. Text only and the default background were used as the baseline for measurement of subject performance. Elaborations from base-

line (e.g., the use of clip art or a custom background) demonstrated the subject's skill at using the technology and represented both knowledge and use. Two outcome variables were thus created: demonstrated skill (DemSk; mean of coders' skill ratings — ranging from -1 to 6) and a more basic measure (coded as 0 or 1) of whether the subject was able to create a presentation and print file (File). Two coders assessed subjects' demonstrated skill with 99 percent agreement.

A post-experimental questionnaire provided manipulation checks for the Information presented (positive and negative description and operational/how-to information). Enough Time (a 1 to 7 rating scale anchored by, "I felt I *did not have enough time* to practice with the system before I had to create my group's presentation," and "I felt I had *enough time to...*") served as the manipulation check for Free Time versus On-the-Job training. Attitudinal outcome measures also were assessed: Satisfaction with the system and training (Satisfaction: 14 semantic differential items adapted from Baroudi and Orlikowski, 1988); and subject's perception of there being more to learn, a two-item measure (More2Learn).

Three control measures were used: Innovativeness, Computer Graphics Experience, and Academic Skill. Innovativeness measured subjects' flexibility and willingness to challenge paradigms (Kirton, 1976) using an adaptation (Marcic, 1992) of Kirton's A-I scale (1976). The original scale has been widely validated and has high internal reliability (Cronbach's Alpha and KR-20 in the range of 0.80 to 0.90) over a variety of samples (Taylor, 1989). Innovativeness controlled for subjects' propensity to push the software to its limits or to try new approaches. Computer Graphics Experience was measured using an open-ended item asking about subjects' experience with presentations. Responses were coded 0/1, subjects coded 1 having some computer graphics experience. Computer Graphics experience controlled for subjects' general skill in creating the presentation materials. Both Innovativeness and Computer Graphics Experience had been assessed earlier in the semester in preparation for the group project. The Academic Skill measure was each subject's current score (out of 515) from exams and other

course work. Academic skill controlled for ability, and/or motivation to perform well on the project. These three measures controlled for individual differences, which have been found to influence the successful implementation of technology (e.g., Alavi and Joachimsthaler, 1992; Bostrom, et al., 1990).

Procedures

The manipulations were provided over the course of two meetings of the course's discussion sections (12 sections with 30 students per section, meeting once per week with a teaching assistant to discuss course material) and a later on-the-job working session. During the first week, experimenters presented a brief Positive Information handout; if the discussion section had been assigned to a Balanced Information condition, subjects also received a Balanced Information overhead presentation of the software system. (The additional information necessary in the Balanced Information conditions was presented via overhead transparencies in order to reduce the possibility for contamination of Positive Description-Biased conditions.) Overhead presentations of the additional information left no hardcopy that might highlight differences among experimental conditions.) During the second week, experimenters returned to the discussion sections to reiterate and reinforce the Information manipulations. The presentations lasted five to 10 minutes during each discussion section and were fully scripted to insure consistency.

At the end of the second week's discussion section presentation, students were asked to volunteer to use the technology to create their class presentation. (Students who had not been present for both information presentations were allowed to use the technology, but not included in the study.) From the volunteer list, eight subjects from each discussion section were randomly assigned to the Free Training condition. These subjects were taken from the discussion section to the computer center. All volunteers were candidly and truthfully informed that only eight subjects were selected from each discussion section because only eight computers were available.

In the Free Training condition, subjects were given 40 minutes to work through the scripted instructions for creating a sample presentation. Once in the computer center, subjects were each handed a step-by-step guide to creating a presentation (commensurate with their Information condition). Subjects were told that each room contained a quick reference guide, a full reference manual, and the sample slides. They were told to do their best to recreate two of the sample slides.

The subjects worked on the sample slides until the end of their scheduled class period. At the end of the class session, all volunteers (both those selected for Free Training and those who remained in class) were offered the opportunity to schedule a three-hour on-the-job working session. This was an opportunity for the students to create presentation materials for their group project and was *not* billed as an experiment.

Thus, the Free-Training condition operationalized costless training by providing regular class time for users to initially experiment and learn about the technology. This training time was completely separate from the time slot provided for actual production. The On-the-Job Performance condition operationalized costly training by allowing the users to interact with and learn about the technology only during their limited time allotted for making presentation slides. Mistakes made during this period would detract from subjects' opportunity to create the actual presentation.

Three-hour time slots were available for the on-the-job working sessions during the two weeks prior to the due date of the class presentations. Subjects were greeted at the computer center by the experimenter and asked if they had with them sketches for prospective slides. (Subjects had been told during the earlier presentations that they were required to have sketches before they came to use the software. This requirement was made to insure that their use of the computer was a serious component of their classwork.) Subjects were handed the instruction materials appropriate for their Information condition, told to follow the instructions very carefully, and reminded of the manuals available in the rooms for their use. Each was then sent to an assigned room.

If subjects said they were finished before the end of the three hour on-the-job working session, the experimenter prompted them to see if there was anything else they would like to try using the software. If not, their files were checked by the experimenter, and they were then given the questionnaire. Subjects were told the questionnaire was needed for feedback about whether to make this software available for future classes. The experimenter printed out each of the files the students had created and made these available to the students for their project presentations. Debriefing was conducted during a regular session of the course.

Results

Manipulation checks

A comparison of the sum of the responses to the four Information manipulation check items revealed that subjects in the Balanced Information condition reported that they were provided with significantly more information than subjects in the Positive Description-Biased condition ($M_{\text{Balanced}}=14.42$, $M_{\text{PosDescB}}=12.52$, $t=-2.49$, $p<.01$).

Subjects in the Free-Training condition did not provide significantly different responses from subjects in the On-The-Job Performance condition for the Enough Time measure ($M_{\text{Free}}=4.84$, $M_{\text{O-J-P}}=4.28$, $t=-1.42$, $p<.16$), although the trend was in the expected direction. Since Enough Time is a state measure of how costly subjects would perceive setbacks encountered in their use of the technology (lower scores meaning setbacks were more costly), subjects' individual responses to the measure were used in the analyses rather than condition assignment. Responses to the Enough Time measure are the result of condition assignment and individual differences in perception. The implications are discussed below.

Analysis

Three dimensions of implementation success were addressed in this analysis: (1) basic utilization of the technology (File) and demonstrated skill level (DemSk), (2) Satisfaction, and (3) perceived need to learn more (More2Learn). Table 1 provides means, standard deviations, and correlations for all variables. Table 2 provides the ordinary least squares analysis of the continuous dependent variables and a logit analysis of the dichotomous variable, File.

Hypothesis 1 predicted that users provided with Positive Description-Biased information about the technology and only On-the-job time to adjust to the technology would have lower satisfaction with the technology. This hypothesis was not supported ($t = -0.35$, $p < .73$). Low power (.06) is of some concern here. Over 3,000 observations would be required for this size effect to result in significant differences. The data suggest the subjects' perceptions that they had Enough Time, regardless of information provided during implementation, has the strongest positive relationship with satisfaction ($t = 3.51$, $p < .001$).

Hypothesis 2 predicted that users provided with Positive Description-Biased information about the technology, and Free Time to adjust to the technology, would be most successful in their use of the technology. The predicted interactions between the Information variable and the Enough Time measure were significant for both the File and DemSk measures of implementation success ($\chi^2_{\text{File}} = 4.02$, $p < .05$; $t_{\text{DemSk}} = 2.06$, $p < .05$). No main effect was found for Enough Time on either measure. Perception of enough time did not, alone, influence performance. There was also a significant positive main effect for Balanced information ($\chi^2_{\text{File}} = 4.03$, $p < .05$; $t_{\text{DemSk}} = 2.25$, $p < .05$). Figure 1 shows the predicted DemSk scores for low and high respondents on Enough Time by Balanced versus PosDescB information conditions. High levels of performance seem to result from either Balanced Information, or Positive Description-Biased information combined with Enough Time. The overall effectiveness of the different strategies is discussed below.

Table 1. Correlation Coefficients for Independent Variables

	PosDescB	Enough Time	Academic Skill	Computer Graphics Experience	Innov.	Satisfac.	File	DemSk	More2Learn
	M=.54 sd=.50	M=4.47 sd=2.14	M=439.98 sd=28.86	M=.22 sd=.42	M=4.41 sd=1.79	M=61.18 sd=15.37	M=.16 sd=.36	M=1.61 sd=1.43	M=6.66 sd=2.56
PosDescB	1.00								
Enough Time	-.01 (127)	1.00							
Academic Skill	-.15 (129)	.02 (127)	1.00						
Computer Graphics Experience	-.21* (129)	.01 (127)	-.12 (129)	1.00					
Innovativeness	.24* (127)	.14 (126)	.02 (127)	.02 (127)	1.00				
Satisfaction	-.02 (121)	.41* (119)	-.09 (121)	.12 (121)	.05 (119)	1.00			
File	.06 (129)	-.18* (127)	-.10 (129)	-.18* (129)	.11 (127)	-.04 (121)	1.00		
DemSk	-.12 (129)	.02 (127)	.18* (129)	.19* (129)	.09 (127)	.04 (121)	-.54* (129)	1.00	
More2Learn	-.01 (128)	-.30* (126)	.01 (128)	-.08 (128)	-.05 (126)	-.46* (120)	-.06 (128)	.17 (128)	1.00

*p <.05, two tailed, number in parenthesis = N. PosDescB was dummy coded 1=Positive Description-Biased, 0=Full Information.

Table 2. Analysis of Dependent Measures for Study 2

	Satisfaction $F(6,111) = 4.15$ $p < .0009$ $R^2 = .18$	File ^a $\chi^2(3,123) = 8.67$ $p < .03$ $R^2 = .08$	DemSk $F(6,119) = 2.56$ $p < .02$ $R^2 = .11$	More2Learn $F(6,118) = 2.29$ $p < .04$ $R^2 = .10$
	β	β	β	β
Intercept	66.46***	2.19*	-2.24	9.09**
PosDescB	1.78	-2.30*	-1.32*	-1.25
Enough Time	3.13***	-0.07	-0.13	-0.50***
PosDescB Enough Time*	-0.44	0.50*	0.24*	0.27
Academic Skill	-0.04		0.01*	0.0002
Computer Graphics Experience	3.35		0.57	-0.44
Innovativeness	-0.05		0.07	-0.03

^aLogit Analysis. Estimates were unstable when control variables were included. Larger χ^2 (twice the -LogLikelihoods) in this analysis indicates better model fit (JMP®User's Guide, 1989, p. 312).

* p <.05. ** p <.01. *** p <.001.

Controlling for Academic Skill, Computer Graphics Experience, and Innovativeness

*Note: A median split was used to create the two Enough Time groups.

Figure 1. Predicted Scores for DemSk: Full Versus Positive Description-Biased Information for Low Versus High* Respondents on Enough Time

Hypothesis 3 predicted that users provided with Balanced information would have the lowest perceived need to learn. This hypothesis was not supported ($t = -1.20, p < .23$). The power for this effect is low (.22), though within the range generally reported for small effects (Lipsey, 1990). A larger sample (e.g., over 300 observations) might have produced a significant result. Enough Time had the only significant effect on the perception that there was more to learn ($t = -3.22, p < .01$) and was negatively related.

Discussion

The concept of the paradox of positive value (Baier, et al., 1982; Sproull and Hofmeister,

1986) was combined with the idea of the paradox of negative experience (Griffith and Northcraft, 1993) to understand implementation success. For attitudes, users' perceptions of having enough time to adjust to the new technology produced a main effect; both satisfaction and feelings of expertise were positively related to users' perceptions of having enough time. Balanced information significantly affected performance; however, limited information (positive description bias) — combined with perceptions of enough time to work with the technology — also yielded high performance. As is discussed below, there may be reasons beyond pure performance that will lead us to choose particular implementation strategies in the field.

The relatively small effect sizes preclude further analysis of this data, but may be explained by the field nature of the study. As in any field research, the incentives for performing may have varied from subject to subject. The incentive structure was based on subjects' need to create presentations for their group projects. Additionally, the complexity of the software may have left many users below the level of expertise they would need to begin the discovery process in the limited time subjects had to work. (Only 23 percent of subjects had any previous computer graphics experience.) Future research could use subjects with broader experience, longer performance periods, and control for subjects' incentives to fully utilize the technology. It is encouraging that the hypothesized performance effects were visible even in this relatively uncontrolled field setting. However, studies of longer-term implementations of complex technologies may provide additional insights into the effects demonstrated here. Organizational or technological complexity could increase the cost of negative surprises; if so, free training may need to address organizational issues as well as technological ones. The key is to anticipate problems — whether technological or organizational — and provide new users with costless ways to learn to solve them.

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