Human Relations, Vol. 45, No. 7, 1992

Development and Test of a Theory of Technological Learning and Usage

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Beliefs, attitudes, and intentions are important factors in the adoption of computer technologies. While contemporary representations have focused on explaining the act of *using* computers, the role of *learning to use* the computer needs to be better understood within the overall adoption process. Inadequate learning can curtail the adoption and use of a potentially productive system. We introduce a new theoretical model, the theory of trying, in which computer learning is conceptualized as a goal determined by three attitude components: attitude toward success, attitude toward failure, and attitude toward the process of goal pursuit. Intentions to try and actual trying are the theoretical mechanisms linking these goal-directed attitudes to goal attainment. An empirical study is conducted to ascertain the construct validity and utility of the new theory within the context of the adoption of a word processing package. Specifically, we examine convergent validity, internal consistency reliability, stability, discriminant validity, criterion related validity, predictive validity, and nomological validity in a longitudinal field study of 107 users of the program. The new theory is compared to two models: the theory of reasoned action from the field of social psychology and the technology acceptance model, recently introduced in the management literature. Overall, the findings stress the importance of scrutinizing the goals of decision makers and their psychological reactions to these goals in the prediction of the adoption of computers.

KEY WORDS: adoption of technology; attitudes; trying; construct validity.

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0018-7267/92/0700-0659$06.50/1

INTRODUCTION

A growing body of research shows that attitudes play an important role in the adoption of computer technologies (e.g., Swanson, 1982, 1988). The general model underlying the acceptance or rejection of computers suggests the following sequence of factors: external variables, e.g., system design characters, → beliefs and evaluations of consequences of use → attitudes → decision making and intentions to use → usage. The present research uses a structural equation methodology to gain a deeper understanding of the nature and organization of these constructs.

Most of the research to date has focused on the causes and effects of attitudes. For example, the evidence supports the dependence of attitudes on the features of systems (e.g., Benbasat & Dexter, 1986; Benbasat, Dexter, & Todd, 1986; Dickson, De Sanctis, & McBride 1986) and the conditions leading to their use (e.g., Alavi, 1984; Baroudi, Olson, & Ives, 1986; Franz & Robey, 1986; c.f., Srinivasan, 1985). Likewise, attitudes have been found to affect intentions to adopt computer technologies (e.g., Davis, Bagozzi, & Warshaw, 1989) and actual usage (e.g., Ginzberg, 1981; Ives, Olson & Baroudi, 1983; Robey, 1979; Swanson, 1987).

Much less attention has been given to the *nature* of attitudes in the adoption of computer technologies. Yet, given its intermediary position in the chain of effects noted above, attitudes may well be a weak link in any program designed to promote the adoption of new technologies. The meaning and measurement of attitudes should not be taken for granted but should be scrutinized in greater depth as they apply to the decision-making process.

Generally, one of two perspectives has been taken on the content of attitudes in the adoption of computer technologies. The older and perhaps more intuitive conceptualization views attitudes as affective reactions toward the characteristics or features of the technological object. A person's attitude in this sense is the felt favorability/unfavorability, liking/disliking, or pleasantness/unpleasantness generated toward the object itself. Although people certainly have attitudinal reactions toward objects and their characteristics, there is no theoretical reason to believe that such attitudes stimulate action. A gap exists in the etiology of behavior between psychological reactions to objects and the actions taken in relation to those objects. In other words, attitudes toward objects do not cause behaviors but rather specific motives to act do. People do not necessarily adopt technologies because of their features *per se*. They do so more for the benefits to which the technologies lead.

Limitations such as these have led psychologists (e.g., Fishbein & Ajzen, 1975) to abandon the study of attitudes toward objects (A_O) and instead focus upon attitudes toward actions (A_{act}). The idea is that attitudes toward actions derive from a consideration of the consequences of acting, e.g., "I am very favorable toward adopting computer X because I think that by doing so it will lead to the favorable consequences of increasing performance and reducing costs." Building on this point of view, Davis et al. (1989) tested a well-known model from the social psychology literature, i.e., the theory of reasoned action, TRA, against a new model from the information systems and management literatures, i.e., the technology acceptance model, TAM, to predict intentions to use a word processing package. Briefly, the TAM adapted the generic TRA model to the particular domain of technology acceptance, replacing the TRA's attitudinal determinants, derived separately for each behavior, with a set of two variables specific to the technology acceptance context, i.e., ease of use and usefulness. Attitudes predicted intentions satisfactorily in both models, but TAM's attitudinal determinants outperformed the TRA's much larger set of predictors.

Although attitudes toward actions are clearly important determinants of the adoption of computer technology, it is important to clarify their boundary conditions. The models that incorporate these attitudes presume that when one forms an intention to act, e.g., use expert system Y, he or she assumes, implicitly at least, that if one tries to act, no impediments will likely stand in the way, such as ability limitations, time constraints, environmental contingencies, and/or unconscious habits. In this sense, the formation of intentions applies to behaviors that are largely *nonproblematic*. Given an attempt to perform such behaviors, the person believes with high likelihood that he or she will perform them. Many computer-related actions are of this sort, such as deciding to use previously-learned spreadsheet procedures, electronic mail, and word processors. However, some actions related to the adoption of computer technologies are *problematic*. By problematic we mean that the decision maker believes that either external or internal impediments could thwart the performance of the action in a particular instance. The *learning* of a new computer technology fits this type of action, at least for many potential users. The TRA and TAM are limited in the sense that they do not specifically address the possibility that people may try, but fail, to undertake the learning activities and experience the outcomes necessary to use a computer.

The purpose of the present research is to develop and test a theory better suited to the learning phase in the adoption of computer technologies. We begin by defining the domain of the dependent variables and introducing a model — the theory of trying (TT) — which is based on new developments in the psychological and consumer behavior literatures. The construct validity of its measures is then assessed in an empirical study. Comparisons are made with the TRA and TAM whenever appropriate. Finally, the article ends with a discussion of the model and its meaning for theory and practice in management.

THE THEORY OF TRYING

Whereas the TRA and TAM view computer use as a behavior completely under volitional control, the learning process for many people represents an impediment which could interfere with efforts to adopt a new program. When the possibility of trying but failing to perform a given action becomes salient to an individual, the consequences of failing may influence their intentions to attempt the action. Such behaviors are referred to as *goals*. As developed below, the TRA and TAM do not address the consequences of trying and failing in the decision process, and a new approach is needed to capture the judgments and reactions potential users have.

Computer Usage Goals

When a decision maker views a behavior as problematic, he or she sees it as a goal. We normally think of goals as end states, such as a particular level of productivity. But a goal can also be the performance of a behavior that a person believes could be problematic for either personal reasons or uncontrollable situational interventions.

What factors are likely to make a behavior a goal for many decision makers? One case is where resources are scarce. For example, consider purchasing a personal computer. For some individuals, this is a behavior and attitude directly leads to action. But for others, an initial down payment must be secured, a loan applied for and accepted, and monthly payments met. And for still others, a series of steps are initiated such as reading published reports, consulting friends, speaking with salespersons, and doing comparison shopping. Each of these steps is a potential stumbling block, at least for some individuals, and therefore purchasing a personal computer is a goal. Other resource constraints include supply availability and time pressures.

A second case where behaviors can function as goals is when a person is lacking in the requisite abilities to perform a behavior and he or she recognizes such. A person may really want to use a computer and have a favorable attitude toward using it but decide not to do so because of a lack of self-confidence. For others, the ability impediment may reside in a lack of knowledge, insufficient will power, or unconscious fears, habits, or prejudices.

Finally, behaviors may be regarded as goals when contingencies in the environment are expected to occur. One's usage of a computer, for example, can be interrupted or facilitated by a whole host of social, institutional, and physical events. To the extent that these are taken into account in one's decision making, usage would be conceived of as a goal in the mind of the decision maker.

Attitudes and Trying

The attitude formation process toward goals is fundamentally different than the attitude formation process toward actions. Typically, attitudes toward actions exist as unidimensional reactions toward the action as a whole (e.g., Ajzen & Fishbein, 1980). The attitude is a singular, global affective, or evaluative response. Attitudes toward goals are more complex, generally existing in multidimensional structures (e.g., Bagozzi & Warshaw, 1990).

Lewin (Lewin, Dembo, Festinger, & Sears, 1944) was one of the first to propose two dimensions of goal-directed attitudes, which he termed valences of success and valences of failure. Warshaw, Sheppard, and Hartwick (forthcoming) speculated that there are three attitudes towards goals: attitudes toward the consequences of *succeeding* to achieve a goal, attitudes toward the consequences of trying but *failing* to achieve a goal, and attitudes toward the *process* of striving to achieve a goal. The first two dimensions are similar to Lewin's valences, the third focuses on the means needed for goal attainment. Ajzen (1985) used the success and failure dimensions in his theory of planned behavior but explicitly rejected attitude toward the process as a separate dimension. Instead, he claimed that process-related considerations "are reflected in attitude toward successful and unsuccessful behavioral attempts" (Ajzen, 1985, p. 32).

To date, the only empirical test of attitudes toward goals has been performed in the weight loss context where all three components — attitudes toward success, failure, and the process of striving to lose weight — achieved construct validity (Bagozzi & Warshaw, 1990). We have incorporated these three dimensions in our study of the adoption of a word processing package. Specifically, we hypothesize that people form distinct attitudes toward the consequences of success (AS), attitudes toward the consequences of failure (AF), and attitudes toward the process of striving to learn to use the word processing package (AP). By examining the construct validity of the measures of these three components in general, and discriminant validity in particular, we should be able to test the three component model vs. Ajzen's (1985) proposed two components.

In addition to the representation of attitudes, we must also respecify the psychological processes occurring between attitudes and action in order to take into account goal pursuit (Bagozzi, 1991). Under the TRA and TAM, attitudes toward usage lead to intentions to use which, in turn, lead to behavior. An assumption inherent in these models is that the focal behavior is completely under volitional control and is nonproblematic from the point of view of the decision maker: i.e., "one typically believes that one can, and will, do whatever one intends or tries to do" (Fishbein & Stasson, 1990, p. 177). But for goals, particularly those requiring skill or effort on the part of the decision maker or those subject to environmental impediments, people regard achievement as problematic. Intentions to use new technologies do not invariably form in response to favorable attitudes, and among those intentions that do form, not all successfully lead to direct usage, without some learning and possibilities at failure or disenchantment occurring. The psychological processes intervening between goal-directed attitudes and goal pursuit are fundamentally different from those occurring between attitudes toward actions and behavior.

To account for the effects of goal-directed attitudes, it is necessary to consider the activation of psychological strivings (Bagozzi, 1991). Goal-directed attitudes reflect one's needs and motivation to pursue a goal. But given the perceived problematic nature of goal-attainment, decision makers typically first form *intentions to try* to achieve a goal. Intentions to try then initiate *trying*, which represents the effort one puts forth in goal pursuit. This effort typically involves the initiation and monitoring of various instrumental acts en route to performance of a target behavior. Notice that the hypothesized sequence of effects is goal-directed attitudes → intentions to try → trying usage. The sequence in the TRA is attitudes toward using → intentions to use → usage. The sequence in the TAM is perceived usefulness and ease of use → intentions to use → usage. Because new technologies such as personal computers are complex and an element of uncertainty exists in the minds of decision makers with respect to the successful adoption of them, people form attitudes and intentions toward trying to learn to use the new technology prior to initiating efforts directed at using. Attitudes toward usage and intentions to use may be ill-formed or lacking in conviction or else may occur only after preliminary strivings to learn to use the technology evolve. Thus, actual usage may not be a direct or immediate consequence of such attitudes and intentions. Decision processes concerning trial and actual efforts resulting therefrom are needed often to transform initial psychological responses into action. We term the proposed framework the theory of trying (TT) to be consistent with the usage in Bagozzi and Warshaw (1990) upon which our theory is based.

We believe that explicit representations of intentions to try and trying, along with their attitudinal determinants, will significantly increase our ability to predict and explain usage behavior compared to the TRA and TAM. We will perform comparison tests of the TT, TRA, and TAM in our study of the adoption of a word processing package described below.

RESEARCH QUESTIONS

The purpose of this study is to develop and test a theory of technological learning and usage. We begin with an examination of the construct validity of the TT, which focuses on learning, and then compare key components and predictions with the TRA and TAM, which focus on usage.

The specific research questions we addressed are the following which have been proposed as aspects of construct validity in the psychometric literature (e.g., Bagozzi, 1981):

1. *Convergent Validity*: the extent to which multiple measurements of a construct are in agreement.

2. *Internal Consistency Reliability*: the degree to which measures reflect a common true score.

3. *Stability*: the amount of change in measures of a true score over time.

4. *Discriminant Validity*: the level of differentiation between measures of distinct constructs.

5. *Criterion Related Validity*: the magnitude of association between measures of a focal construct and measures of another construct expected to covary with the focal construct.

6. *Predictive Validity*: the accuracy with which measures of a construct forecast measures of another construct when the constructs are expected to be related on the basis of theory.

7. *Nomological Validity*: the accuracy with which measures of a construct forecast measures of other constructs when all constructs are related as part of an underlying theoretical network of hypotheses.

Each of these criteria represents a necessary condition for construct validity. They are arranged in order from the most basic or easiest to satisfy to the more complex and difficult to attain. Predictive validity and nomological validity differ as a matter of degree and not kind and may be considered as opposite poles of a theoretical continuum. The former scrutinizes how well the focal construct predicts a single criterion of theoretical interest; the latter investigates how well the focal construct functions within an entire network of hypotheses comprised of many predictions. The difference is somewhat analogous to the distinction between univariate and multivariate statistics. The particular model specifications, as applied to measures in the theory of trying and comparison attitude frameworks, will be described in detail in the Methods Section.

METHOD

Subjects and Overview

To assess the measurement and validation issues noted above, we gathered data from 107 full-time MBA students during their first semester in the MBA program at The University of Michigan. Two questionnaires were administered, one immediately after a 1-hour introduction to the personal computer and software used in the program and a second at the end of the semester 14 weeks later. Due to incomplete responses on some items from 11 respondents, the final sample size for study was 96. Students provided their attitudes, intentions, and other reactions toward the specific word processing program, WriteOne, which was the only option available to them. It is unlikely that respondents had prior experience with this rather obscure program and therefore a relatively strong basis exists for supporting the causal sequences of attitudes → (decisions to use and usage) rather than the reverse. In this respect, our study can be considered a quasi-experiment (e.g., Cook & Campbell, 1979). Word processing was chosen as the focal computer technology because: (1) it is a voluntarily used package, unlike spreadsheets and statistical programs that students are required to use in one or more courses, (2) students would face opportunities to use a word processor throughout the MBA program for memos, letters, reports, resumes, and the like, and (3) word processors are among the most frequently used categories of software among practicing managers (Benson, 1983; Honan, 1986; Lee, 1986).

Questionnaire

Theory of Trying. Attitudes toward success (AS), failure (AF), and the process (AP) of learning to use the word processing package effectively were each measured with two 7-point semantic differential items anchored by pleasant–unpleasant and pleasurable–painful endpoints. Overall attitude toward trying (AT) to learn the word processing package, which was used as a variable to test for the criterion-related and discriminant validities of AS, AF, and AP, was measured with a 7-point good–bad item. Intentions to try (I_t) to use the word processing package were measured at the first wave with the item: "I presently *intend to try* learning to use WriteOne effectively this semester." A 7-point likely-unlikely format was employed. At the second wave, the extent of trying (T) to learn to use the word processing package was measured with the item: "How much effort did you put forth *trying to learn* to use WriteOne effectively this semester?" Response alternatives were "no effort at all," "little effort," "moderate effort," "extensive effort," and "extreme effort."

Theory of Reasoned Action. Attitude toward using (AU) the word processing package was indicated by pleasant–unpleasant and pleasurable–painful items each with 7-point response alternatives. Intentions to use (I_u the word processing package were measured with two items. One was a 7-point likely–unlikely item. The second was an 11-point definitely no–definitely yes item.

Technology Acceptance Model. Perceived ease of use (EOU) was measured with two 7-point likely-unlikely items. One item stated, "I would find it easy to get WriteOne to do what I want it to do," the second asserted, "I would find WriteOne easy to use." Perceived usefulness (USF) was indicated by three 7-point likely–unlikely items. The three respective items were worded as follows: "Using WriteOne would improve my performance in the MBA program," "using WriteOne in the MBA program would increase my productivity," and "using WriteOne would enhance my effectiveness in the MBA program." The EOU and USF items were selected from the original list of items developed by Davis (1989) based on confirmatory factor analyses. All 7-point items employed in this study contained the following descriptors for each response alternative: "extremely," "quite," "slightly," "neither," "slightly," "quite," and "extremely."

Behavior was measured as the frequency of use and recorded at the end of the study 14 weeks into the semester. The item began, "I currently use WriteOne (select most accurate answer)," and the following seven response alternatives were provided: "not at all," "less than once a week," "about once a week," "2 or 3 times a week," "4 to 6 times a week," "about once a day," and "several times a day."

Analytical Procedures and Models

The LISREL7 program was used to test hypotheses (Jöreskog & Söbom, 1989). Figure 1 shows the structural equation models needed to examine the first five aspects of construct validity noted above.

In Figure 1a, a confirmatory factor analysis model is presented for testing convergent validity and computing internal consistency reliability. The three goal-directed attitudinal components: attitudes toward success

(AS), failure (AF), and the process of trying to learn to use the word processing package (AP), are shown as circles, i.e., factors. The intercorrelations among the factors are represented with curve line segments and indicated by Φ_{ij}s. The respective measures of AS, AF, and AP are drawn as boxes and designated as x_is. The measurement errors are depicted with arrows and labelled with δ_is. The relationship between the attitudinal components and measures are factor loadings, i.e., γ_is. One factor loading for each factor is shown constrained to 1.00 to scale the factor in the same unit of measurement as the respective measure.

The model in Fig. 1a is termed a measurement model in the literature (Jöreskog & Sörbom, 1989). It represents the null hypothesis that the measures of the attitudinal components load highly only on their respective factors and that all the variances in the measures are due to the factors plus error. This can be tested with a chi-square goodness-of-fit test where a probability greater than or equal to .05 indicates a satisfactory fit.

The LISREL7 program also provides two additional diagnostics for interpreting the adequacy of model fit. The adjusted goodness-of-fit index (AGFI) is defined as 1 minus the ratio of the minimum of the fit function (after fitting) to the fit function before fitting, corrected for degrees of freedom. It generally is bounded by 0 and 1 with values of approximately .90 and greater considered satisfactory. The AGFI is "independent of the sample size and relatively robust against departures from normality" (Jöreskog & Sörbom, 1989, p. 43). The root mean square residual (RMR) indicates the average of fitted residuals. Its value should be low, approximately .07 or less, say.

Parameter estimates derived from the estimation of the model in Fig. 1a can be used to perform a number of informative analyses. The variance in measures can be partitioned into that due to trait, i.e., attitudinal component, and error. The variance due to a trait is equal to the square of the respective factor loading, while error variance is provided directly by the LISREL7 program. The average variance extracted (AVE) can be computed for each attitudinal component as the ratio of the sum of squared factor loadings to the sum of squared factor loadings plus error. The AVE is bounded by 0 and 1 and should be at least .50. The composite reliability of measures for each attitudinal component, which is analogous to Cronbach Alpha, can be computed as the ratio of the sum of factor loadings quantity squared to the sum of factor loadings quantity squared plus error. This should generally be greater than about .70. The uniqueness of attitudinal components can be assessed by inspecting the Φ_{ij}s. Each Φ_{ij} should be less than 1.00 by an amount greater than twice its respective standard error.

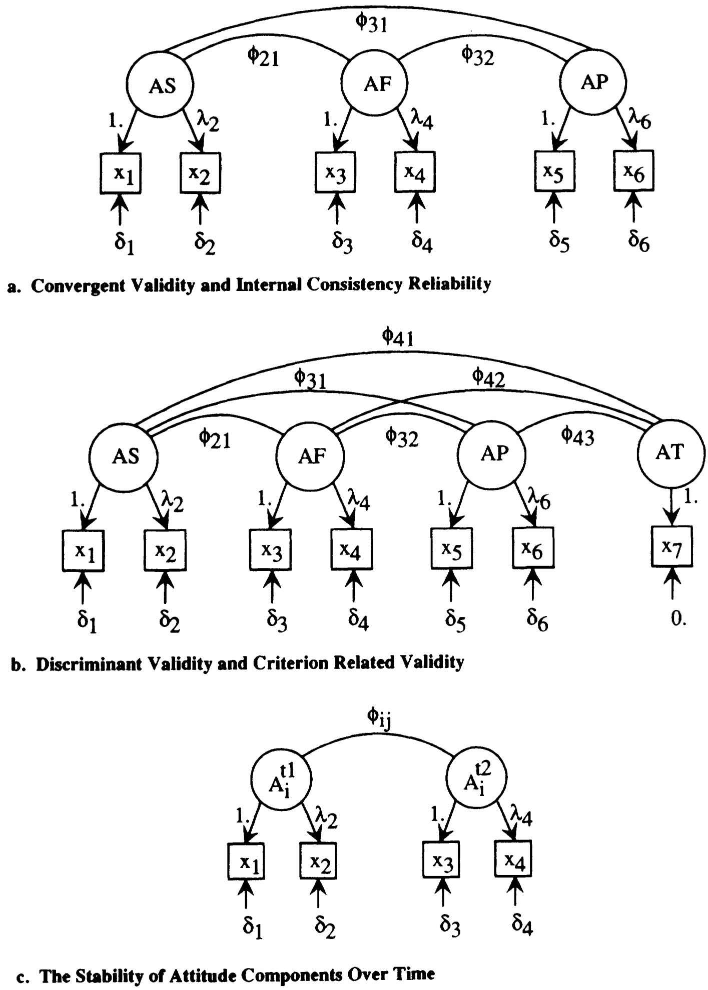


Fig. 1. Confirmatory factor analysis' models for examining validity, reliability, and stability of the theory of trying (see text for definition of symbols).

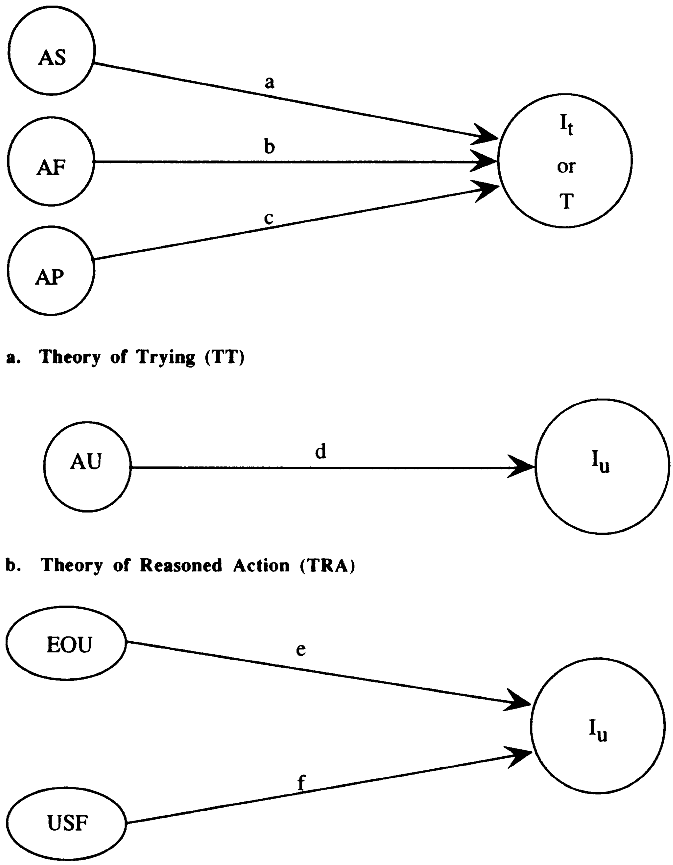
Figure 1b can be used to examine discriminant validity and criterion-related validity. Discriminant validity between each respective attitudinal component and attitude toward trying (AT), the criterion, can be ascertained by examining Φ_{41}, Φ_{42}, Φ_{43}. These correlations should be substantially less than 1.00, i.e., Φ_{ij} should be less than 1.00 by an amount greater than twice its respective standard error. Criterion-related validity is achieved when Φ_{41}, Φ_{42}, and Φ_{43} are statistically significant and in the direction implied by theory. Discriminant validity among the attitudinal components can be determined likewise by inspection of Φ_{31}, Φ_{21}, Φ_{32}, and their respective standard errors.

The stability of the attitudinal components over time can be determined by estimating the model shown in Fig. 1c. Stability is indicated by Φ_{ij} which is the correlation between attitudinal factors over time. This correlation is automatically corrected for attenuation due to measurement error, as a consequence of the confirmatory factor analysis procedure in LISREL7.

Predictive validity can be examined as presented in Fig. 2. In Fig. 2a we show the TT predicting either intentions to try (I_t) at time 1 or actual trying (T) at time 2. Figure. 2b shows the prediction implied by the TRA, and Fig. 2c illustrates the predictions peculiar to the TAM. The adequacy of predictive validity can be assessed by inspecting the significance of predictors. Further insight can be obtained by examining R^2 values and comparing these across models. We also investigate the cross predictions and R^2 values produced when each attitudinal theory predicts the criteria associated with the others. This is done for comparison purposes and permits us to scrutinize the boundary conditions for the models.

Figure 3 illustrates the models for testing nomological validity. The objective of tests of nomological validity is to ascertain the extent to which predictions from key constructs in a network of hypotheses are consistent with theory. In each test of nomological validity, the focal criterion of interest is actual usage (USE) of the word processing package. Under the TT, the three attitudinal components (AS, AF, AP) are shown predicting I_t at time 1 to reflect motives and volitions during the initial stage of learning immediately following the 1-hour introduction to the word processing package. Subsequent learning then is hypothesized to lead to intentions to use (I_u) the package at time 2. Intentions to use, in turn, lead to both further strivings — termed trying (T) — and actual use. Usage is also a direct function of trying.

Figure 3b shows the model for the test of nomological validity of the TRA. Consistent with theory, attitudes toward using (A_u) and subjective norms toward using (SN) determine I_u at time 1. Intentions to use at time 2 then influence USE directly. We have included I_u at both points in time in order to test for the effects of changing intentions over the 14-week period. Figure 2c presents the model for the test of nomological validity of the TAM. The perceived usefulness (USF) and ease of use (EOU) of the package lead to intentions to use and subsequent USE. As with the TT and TRA, we have included initial and final intentions in order to allow for the effects of learning.



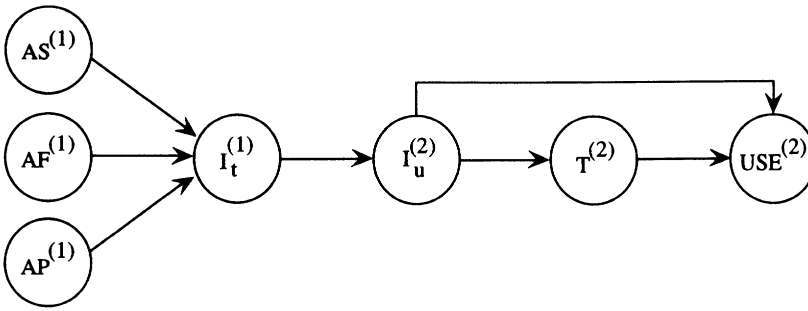
a. Theory of Trying (TT)

b. Theory of Reasoned Action (TRA)

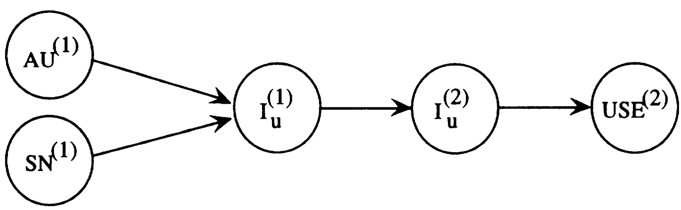
c. Technology Acceptance Model (TAM)

Fig. 2. Three models for testing and comparing predictive validity of the theory of trying, theory of reasoned action, and technology acceptance model (see text for definition of symbols).

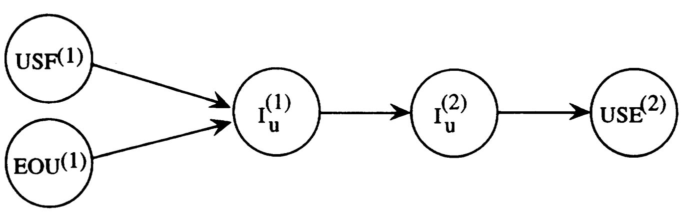
Unlike Bagozzi and Warshaw (1990) in their study of weight loss, we have not included expectations of success and failure and their interactions with AS and AF, respectively, in the tests of nomological validity. Our tests of the interaction effects using hierarchical regression showed that neither interaction was significant. With hindsight, we suspect that this finding is a consequence of the sample. Most MBAs, have, or at least express, high levels of confidence and are inclined to rate their expectations of success (ES) in learning the word processing package very high and their expectations of



a. The Theory of Trying



b. The Theory of Reasoned Action



c. The Technology Acceptance Model

Fig. 3. Nomological validity models.

failure (EF) very low. This was in fact the case: M_{ES} = 2.21 (*SD* = 1.47) and M_{EF} = 6.16 (*SD* = .97), where both items were measured on 7-point likely–unlikely scales.

RESULTS

Before we present our findings, we wish to comment on the attrition in the sample over the 14-week period of the study. The fact that we

Table I. Convergent and Discriminant Validity for Measures of the Theory of Trying (see Fig. 1a)[a]

	Time 1	Time 2
	Goodness-of-fit measures	
	$\chi^2(6) = 7.69$	$\chi^2(6) = 10.92$
	$p \sim .26$	$p \sim .09$
	AGFI = .92	AGFI = .89
	RMR = .03	RMR = .03

Attitude measure	Partitioning of variance into trait (error) variance			
AS1	.60[d]	(.40[d])	.64[d]	(.36[d])
AS2	.66[d]	(.34[d])	.64[d]	(.36[d])
AF1	.92[d]	(.08[d])	.48[d]	(.52[d])
AF2	.71[d]	(.29[d])	.56[d]	(.44[d])
AP1	.59[d]	(.41[d])	.86[d]	(.14[c])
AP2	.70[d]	(.30[d])	.64[d]	(.36[d])

		Correlations among traits					
		AS	AF	AP	AS	AF	AP
	AS	1.00			1.00		
Φ_{ij} (SE)	AF	−.55[d]	1.00		−.53[d]	1.00	
	AP	.56[d]	−.16[b]	1.00	.46[d]	−.12	1.00

[a] AS = attitude toward success, AF = attitude toward failure, and AP = attitude toward the process of learning to use the word processing package; AGFI = adjusted goodness-of-fit index, RMR = root mean square residual.
[b] $p < .15$.
[c] $p < .01$.
[d] $p < .001$.

omitted 11 incomplete responses could compromise the generality of our findings if these subjects failed to respond because they were not trying to use the system. Since all 11 of the respondents completed the trying question (the incompleteness stemming from nonresponse on some other questions), we were able to test this hypothesis. The average of the trying measure was 3.13 without the incomplete responses, and 3.14 including the incomplete responses. Therefore, the omitted subjects actually tried slightly harder than the remaining subjects, although the effect on the mean of .01 is not enough to change the statistical findings.

Convergent Validity. The model in Fig. 1a was tested separately at times 1 and 2. Table I presents the findings. The goodness-of-fit measures indicate that convergent validity has been achieved in each instance. The partitioning of variance reveals that trait variation ranges from moderate to high and error variance is generally low. An inspection of the intercorrelations

Table II. Internal Consistency Reliability for Measures of the Theory of Trying[a]

Attitude	Time 1	Time 2
	Average variance extracted	
AS	.63	.64
AF	.82	.52
AP	.63	.75
	Composite reliability	
AS	.77	.78
AF	.90	.68
AP	.69	.86

[a] AS = attitude toward success, AF = attitude toward failure, and AP = attitude toward the process of learning to use the word processing package.

among traits demonstrates that the three components—AS, AF, and AP—are distinct, i.e., each is substantially less than 1.00, and correlate positively at low to moderate levels.

Internal Consistency Reliability. Table II presents the findings for reliability. The AVE ranges from .52 to .82, which is satisfactory. The composite reliabilities are also satisfactory and range from .68 to .90. Overall, the measures of AS, AF, and AP achieve internal consistency.

Stability. Table III summarizes the findings for test–retest stability over the 14-week period (see Fig. 1c). The goodness-of-fit measures for the models of AF and AP indicate satisfactory fits, but the model for AS fits poorly overall, perhaps as a consequence of the differential effects of omitted variables over time. Nevertheless, AS achieves the greatest stability over time ($\Phi_{21} = .55$), AP the least ($\Phi_{21} = .33$), and AF in the middle ($\Phi_{21} = .43$). For attitudinal measures toward an activity that was initially new and that one interacts with weekly if not daily, these can be considered surprisingly stable.

Discriminant and Criterion-Related Validities. Table IV shows the findings for the test of the model in Fig. 1b. The goodness-of-fit measures suggest that the model fits well at both points in time. The correlations of the attitudinal components with the criterion range from .25 to .64 and are significant in each case. Thus, criterion-related validity is established. Moreover, each attitudinal component is correlated with the criterion at a level well below 1.00, i.e., the respective correlations are less than 1.00 by an amount greater than two standard errors. This, then, demonstrates

Table III. Test–Retest Stability for Measures of the Theory of Trying (see Fig. 1c)[a]

Attitude component	Goodness-of-fit measures	Test–retest correlation corrected for attenuation Φ_{ij}
AS	$\chi^2(1) = 8.46$ $p \sim .00$ AGFI = .65 RMR = .04	.55[c]
AF	$\chi^2(1) = .51$ $p \sim .48$ AGFI = .98 RMR = .01	.43[c]
AP	$\chi^2(1) = 1.08$ $p \sim .30$ AGFI = .95 RMR = .01	.33[b]

[a] AS = attitude toward success, AF = attitude toward failure, and AP = attitude toward the process of learning to use the work processing package; AGFI = adjusted goodness-of-fit index, and RMR = root mean square residual.
[b] $p < .01$.
[c] $p < .001$.

that AS, AF, and AP are distinct from AT and thus show discriminant validity.

Predictive Validity. The goodness-of-fit measures for the tests of the predictive models shown in Fig. 2 are displayed in Table V. Notice first that the model for the TT fits well when predicting all four criteria (see row 1 in Table V). The goodness-of-fit for the TRA is poor when predicting intentions to use the word processing program at time 1 but is satisfactory at time 2. The models for TAM show satisfactory goodnesses-of-fit.

Table VI summarizes the key parameter estimates and R^2 values for the predictive models. The TT shows significant parameter estimates ($p < .05$ or better) in all cases except for AP predicting intentions to try where the parameter is significant at only the .08 level. With respect to the TRA, the correlations between AU and I_t and AU and T are positive and significant, and AU was found to positively and significantly predict I_u at both points in time. Under TAM, EOU is a significant predictor only of I_u at time 1, but USF significantly predicts the criteria according to theory in all cases.

Table IV. Discriminant Validity and Criterion Related Validity for Measures of the Theory of Trying (see Fig. 1b)[a]

	Time 1	Time 2
	Goodness-of-fit measures	
	$\chi^2(10) = 11.27$ $p \sim .34$ AGFI = .92 RMR = .03	$\chi^2(10) = 9.94$ $p \sim .45$ AGFI = .93 RMR = .04
Φ_{ij}	Correlation with attitudinal criterion	
AS	.42[c]	.32[b]
AF	-.42[c]	-.25[b]
AP	.43[c]	.64[c]

[a] AS = attitude toward success, AF = attitude toward failure, and AP = attitude toward the process of learning to use the work processing package; AGFI = adjusted goodness-of-fit index, RMR = root mean square residual.
[b] $p < .01$.
[c] $p < .001$.

The summary of R^2 values in the bottom of Table VI shows that the TT predicts I_t and T at levels greater than those found for the TRA and TAM. The TAM achieves the highest R^2 values for I_u of any of the three models. The TRA performs the poorest with respect to R^2 in every instance.

Nomological Validity. The models shown in Fig. 3 were applied to the data. The overall goodness-of-fit measures for the TT are shown in the first column of Table VII where it can be seen that each criterion is satisfactory. The overall goodness-of-fit measures for the TRA are presented in the second column of Table VII. All criteria point to a satisfactory model fit. Finally, the third column of Table VII lists the overall goodness-of-fit measures for the TAM. Although the criteria suggest a poor fit, the findings are nearly acceptable and therefore will be examined for comparative purposes.

Table VIII presents the parameter estimates and R^2 values for the nomological validity models. Notice first that all predictions in each model are borne-out with one exception. In the TRA, subjective norm (SN) fails to significantly predict intentions. Thus, the theoretical hypotheses implied by the TT, TRA, and TAM generally receive strong support, and nomological validity is established. The R^2 values shown in the bottom of Table VIII permit comparisons of explained variance across models for intentions to use at time 2 ($I^{(2)}{}_u$) and actual usage

Table V. Predictive Validity for Measures of the Theory of Trying (TT), the Theory of Reasoned Action (TRA), and the Technology Acceptance Model (TAM): Goodness-of-fit Measures (see Fig. 2)[a]

	Time 1		Time 2	
	Criterion			
Theory	Intentions to try	Intentions to use	Trying	Intentions to use
TT	$\chi^2(9) = 11.21$ $p \sim .26$ AGFI = .90 RMR = .04	$\chi^2(14) = 25.94$ $p \sim .03$ AGFI = .84 RMR = .04	$\chi^2(9) = 7.84$ $p \sim .55$ AGFI = .93 RMR = .03	$\chi^2(14) = 17.85$ $p \sim .21$ AGFI = .89 RMR = .04
TRA	NA[b]	$\chi^2(1) = 8.77$ $p \sim .00$ AGFI = .58 RMR = .03	NA	$\chi^2(1) = .11$ $p \sim .74$ AGFI = .99 RMR = .00
TAM	$\chi^2(7) = 11.66$ $p \sim .11$ AGFI = .90 RMR = .04	$\chi^2(11) = 12.26$ $p \sim .34$ AGFI = .92 RMR = .04	$\chi^2(7) = 9.66$ $p \sim .21$ AGFI = .92 RMR = .03	$\chi^2(11) = 18.35$ $p \sim .07$ AGFI = .89 RMR = .03

[a] AGFI = adjusted goodness-of-fit index, and RMR = root mean square residual.
[b] NA = not applicable. With only a total of three measures for the two constricts it is not possible to use structural equation models.

(USE). It can be seen that the TRA (R^2 = .34) and TAM (R^2 = .35) explain much more variance in $I^{(2)}{}_u$ than the TT (R^2 = .11). The TT (R^2 = .44), in contrast, explains the most variation in USE, followed closely by the TAM (R^2 = .39), and less well by the TRA (R^2 = .22).

DISCUSSION

The evidence strongly supports the contention that, when contemplating the adoption of a novel technology, people form multidimensional attitudes toward learning to use the technology. In our study, the findings reveal that three distinct attitudinal components exist: attitudes toward success, failure, and the process of trying to learn the word processing package effectively. This was shown in the measures of reliability and stability, and in the tests of validity. Thus, the attitude formation process in the TT is found to hold for the adoption of computer technology.

Of particular interest is the functionality of the attitudinal components. The first time use of any novel technology is predicated on the steps

Table VI. Predictive Validity for Measures of the Theory of Trying (TT), the Theory of Reasoned Action (TRA), and the Technology Acceptance Model (TAM): Parameter Estimates and R^2 Values (see Fig. 2)[a]

	Time 1		Time 2	
	Parameter estimates			
Theory/ predictors	Intentions to try	Intentions to use	Trying	Intentions to use
TT				
AS	.51[f]	.87[f]	.82[f]	.82[f]
AF	-.97[f]	-.75[f]	-.50[f]	-.68[f]
AP	.19[d]	.45[f]	.39[f]	.39[e]
TRA				
AU	.33[b,f]	.50[f]	.36[b,f]	.38[f]
TAM				
EOU	.10	.25[f]	-.03	-.02
USF	.48[f]	.58[f]	.39[f]	.74[f]
	R^2 values			
TT	.43[c]	.28	.23[c]	.36
TRA	.11	.25	.13	.15
TAM	.26	.46[c]	.16	.54[c]

[a] AS = attitude toward success, AF = attitude toward failure, and AP = attitude toward the process of learning to use the word processing package; AU = attitude toward using, EOU = ease of use, and USF = usefulness.
[b] Pearson product-moment correlation.
[c] TT best fits the trying measure, TAM best fits the use measure.
[d] $p < .10$.
[e] $p < .01$.
[f] $p < .001$.

one takes *to learn to use* the technology. The steps entail efforts or strivings at learning and are reflected in instrumental actions one initiates. We termed these, trying. Whether one will try or not is dependent, in turn, on intentions to try which serve as volitional mechanisms transforming one's needs and motives with respect to achieving a level of learning as a goal into action. The anticipated consequences of successfully achieving the goal, failing to do so, and undergoing the efforts to do so are summarized in one's attitudes toward goal pursuit. The decision process really begins with the formation of these attitudes.

In terms of predictions under each of the models, it was found that intentions to try and trying are best forecast by attitudes toward success,

Table VII. Nomological Validity Results for the Theory of Trying (TT), the Theory of Reasoned Action (TRA), and Technology Acceptance Model (TAM): Goodness-of-fit Measures (see Fig. 3)[a]

Criterion	TT	TRA	TAM
$\chi^2(df)$	48.24 (39)	29.00 (18)	59.26 (33)
p	.15	.05	.00
AGFI	.88	.89	.85
RMR	.08	.03	.15

[a] AGFI = adjusted goodness-of-fit index and RMR = root mean square residual.

failure, and the process, as the TT suggests. Decision making and actions needed to learn the word processing package are driven by attitudinal reactions toward the gains foreseen by achieving this goal, the losses anticipated should one fail, and the pleasurable and noxious experiences one will accrue along the way. The TRA and TAM, which are designed to explain usage, performed significantly less well than the TT in the prediction of intentions to try and trying.

Under the TT, an inspection of the relative contributions of the attitudinal components as predictors leads to some interesting conclusions (see top of Table VI). At time 1 before people have learned the word processing package, the consequences of failure are the strongest determinants of intentions to try to learn. The greater the negative affect felt in anticipation of failure to learn the package, the weaker the intentions to do so. Indeed, the fear of failure is nearly twice as strong in its effects as the positive affect associated with the perceived consequences of successfully learning the word processing package. Apparently, at the outset of the semester after an introduction to the computer and word processing, MBA students experience a significant amount of anxiety. Attitude toward the process, in contrast, has the weakest effects at this point in time, being about 20% and 40% as important as attitudes toward failure and success, respectively.

Fourteen weeks later, after the subjects had a chance to learn the word processing package, attitudes, and their functions change. Actual trying is determined most by attitudes toward the consequences of success. Attitudes toward failure become much less important and in fact are about 60% as strong as attitudes toward success. Attitudes toward the process increase in salience but still contribute only about half as much of the effect on actual trying as attitudes toward success. Thus, trying to learn to use the word processing package is driven primarily by one's attitude toward the anticipated consequences of success.

Table VIII. Nomological Validity Results for the Theory of Trying (TT), the Theory of Reasoned Action (TRA, and Technology Acceptance Model (TAM): Parameter Estimates and R^2 Values (see Fig. 3)[a]

	Parameter estimates		
Causal relation	TT	TRA	TAM
AS → I_t	.41[e]	—	—
AF → I_t	–.58[e]	—	—
AP → I_t	.20[d]	—	—
AU → $I_u(1)$	—[b]	.42[e]	—
USF → $I_u(1)$	—	—	.63[e]
EOU → $I_u(1)$	—	—	.28[e]
SN → $I_u(1)$	—	.13[c]	—
I_t → $I_u(2)$	.33[e]	—	—
$I_u(1)$ → $I_u(2)$	—	.58[e]	.59[e]
$I_u(2)$ → T	.58[e]	—	—
$I_u(2)$ → USE	.39e	.52[e]	.54[e]
T → USE	.35[e]	—	—
$R^2_{I_t}$	.47	—	—
$R^2_{I_u}(1)$	—	.22	.54
$R^2_{I_u}(2)$	.11	.34	.35
R_T2	.34	—	—
R^2_{USE}	.44	.22	.39

[a] AS = attitude toward success, AF = attitude toward failure, and AP = attitude toward the process of learning to use the word processing package; AU = attitude toward using, USF = usefulness, EOU = ease of use, SN = subjective norm, I_t = intention to try, I_u = intention to use, T = trying, and USE = usage.
[b] Not applicable.
[c] $p < .15$.
[d] $p < .01$.
[e] $p < .001$.

Our research shows that the psychological processes associated with goal formation and the pursuit of goals are important considerations in the adoption of computer technologies. These processes — reflected in attitudes toward success, failure, and the means of goal pursuit, intentions to try, and trying activities — are early responses to problem solving and precede adoption and long-run usage. Further research is needed into the initiation, monitoring, and control of instrumental actions underlying both the learning and use of computer technologies (Bagozzi, 1991).

More research is needed also to understand how attitudes toward success, failure, and trying are formed and changed. Following the approach used in the theory of reasoned action (Ajzen & Fishbein, 1980), researchers could interview subjects to determine salient beliefs they hold about trying and succeeding, trying and failing, and the process of trying *per se*. This could lead to persuasion strategies aimed at minimizing the beliefs associated with negative consequences and maximizing beliefs associated with positive consequences. The impact of various external factors on beliefs and attitudes should be examined, such as past experience, education, and social processes. A related issue is how realistic expectations of success and failure are. Someone who previously had a difficult time learning a program may erroneously generalize their experience to a new situation, undermining their persistence. Self-fulfilling prophecies may work the opposite way as well: a person with a higher expectation of success may try harder and increase his or her chances of overcoming learning impediments. People may have varying definitions of success and failure: a successful level of performance for one person may represent failure to another. This needs attention in future studies. The present research provides a starting point for investigations into these issues.

It is unclear how far our results will generalize to other subject samples. MBA students may not be representative of the total population of potential computer users in terms of their experience and motivation. For instance, they may have higher expectations of success and lower expectations of failure than other groups. A restriction of the range on these expectations may have prevented them from moderating the attitude–intention relationship. Further research may apply this model on other subject populations having greater diversity in terms of expectations of success or failure. Alternately, future research may experimentally manipulate expectations of success and failure, for example, by altering the nature of the information system interface. A related issue that may limit the generalizability of our findings concerns the possibility in any questionnaire-based study that respondents may answer questions according to their own lay theories of the relationships between questions being asked (e.g., Budd, 1987; Feldman & Lynch, 1988). Unfortunately, little is known presently about the lay theories users may have about technology adoption. The research by Long et al. (1983), which involved in-depth content analyses of verbal statements from users regarding their views toward the introduction of computers at work, provides a starting point for understanding lay theories of technology adoption.

POLICY IMPLICATIONS

Young (1984) reports that as many as 25% of microcomputers sold end up collecting dust primarily because their owners never learned how to use them. Clearly, one's intention to use the computer, which leads people to acquire the systems in the first place, does not assure that sustained usage will occur. The findings reported above suggest that use of a computer is influenced both by one's intention to *use* it and by the degree to which the person *tries to learn how* to use it. Negative emotional reactions toward learning how to use the system may inhibit someone from trying to learn it despite the fact that they regard it as useful and easy to use. The results presented above suggest that intention to try to learn a system is a function of attitudes toward success, failure, and the process of trying. Successful learning implies that the user can get on with the task for which they may have formed a tentative intention to use the system in the first place. If the prospect of learning presents risks of failure and associated affective reactions, the propensity to learn can be subverted. Similarly, if the process of learning *per se* is unpleasant or overly effortful, the overall motivation to learn may be suppressed.

Some instructional strategies have been successful by attempting to reduce the risk of failure. Examples of this include the "training wheels" interface developed by Carroll and Carrithers (1984) which presents the full user interface to users, but encourages the exploration of capabilities by disabling advanced commands which are prone to especially difficult errors. Using the training wheels system, people experienced fewer errors and spent less time recovering from errors. Jagodzinski (1983) proposed the use of a "reconnoiter mode" that allows the user to try proposed action sequences in the form of a simulation in order to verify their correctness before permanently implementing them. The use of "undo" commands which can conveniently reverse the unintended effects of commands can similarly reduce the risks associated with learning the system. All of these methods may influence intentions to try to learn by reducing the incidence of failures.

Our results suggest that changing people's attitudes toward the process of learning, irrespective of success or failure, may be an effective way to improve the motivation to learn. Research has shown that computer learning is often "active" in the sense that people attempt to solve real tasks as soon as possible when using a new system, and consult manuals only as needed (Mack, Lewis, & Carroll, 1983). Such "learning by doing" has been shown to be effective in non-computer domains, and may be successful as a generic learning strategy. Unfortunately, as Carroll and Rosson (1987) argue, such active learning leads to a "production bias" in which the motivation to *use* the system to get a task done is stronger than the motivation to spend time *learning to use* the system. As a consequence, learning is impeded, resulting in lack of adoption, or adoption with skills leveling off at a mediocre level. To combat this, instructional approaches that increase the intrinsic enjoyment of the learning process to counteract the production bias, or take advantage of the production bias have proven effective. Malone (1981) suggests using design features which have proven successful in computer games, such as fantasy, challenge, and curiosity. Carroll and Thomas (1982) suggest that using interesting metaphors such as flight simulators as interfaces to routine applications could increase intrinsic motivation. McKendree, Schorno, and Carroll (1985) have incorporated several intrinsically motivating features into an experimental system, including a dialogue that challenges users to perform tasks and gives them feedback on performance. Overall, a number of fruitful guidelines thus exist for improving the learning and on-going use of computer technologies.

From a practical standpoint, the models and measures introduced here should be useful for evaluating training strategies, software designs, and system development and implementation techniques. For example, Kalen and Allwood (1991) found that among 265 Swedish companies, group instruction with simultaneous computer exercises was the predominant training strategy, used far more often than self-study from manuals, computerized instruction, and other formats. However, these researchers did not assess the effectiveness of the various training options. Czaja et al. (1986) compared three different types of training strategies (instructor, manual, and computer), and found that computer-based training was less effective than the other two methods. Our models may contribute to a better understanding of why this pattern of results occurred. Allwood and Wikstrom (1986) identify several types of difficulties users encounter when attempting to learn complex computer programs, and observed a large variation in learning strategy. The models introduced here should complement that type of research by allowing researchers to assess the impact of software design and learning strategy on attitudinal determinants of learning behavior. The interrelationship between computer anxiety (Howard, 1986) and the constructs found in our models should be examined. More broadly, future research is needed to better understand how to influence the various determinants of computer learning addressed in this research. For example, the effect of various systems design and implementations processes should be investigated in this regard (e.g., Bjorn-Anderson, Eason, & Robey, 1986; Eason, 1982, 1987, 1988; Mumford & Weier, 1979).

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