December 2002

EXTENDING THE TASK-TECHNOLOGY FIT MODEL WITH SELF-EFFICACY CONSTRUCTS

Mark Dishaw
University of Wisconsin Oshkosh

Diane Strong
Worcester Polytechnic Institute

D. Brent Bandy
University of Wisconsin Oshkosh

EXTENDING THE TASK-TECHNOLOGY FIT MODEL WITH SELF-EFFICACY CONSTRUCTS

Mark T. Dishaw
University of Wisconsin Oshkosh
dishaw@uwosh.edu

Diane M. Strong
Worcester Polytechnic Institute
dstrong@wpi.edu

D. Brent Bandy
University of Wisconsin Oshkosh
bandy@uwosh.edu

Abstract

MIS researchers have developed a number of models for studying the software utilization choices of end users, including the Task-Technology Fit Model and the Technology Acceptance Model. We are exploring the similarities and differences among these models with a goal of developing combined models with more explanatory power. This paper proposes a model that extends the task-technology fit model with a computer self-efficacy construct.

Keywords: Task-technology fit, computer self-efficacy, technology acceptance model

Introduction

In today's world of desktop computing, users have many choices about the software they use, e.g., different email packages, web browsers, and graphics packages. Desktop users may choose the extent of use of any software package and the tasks for which they use the software. MIS researchers have developed models to study the software utilization choices of end users. Two of the most frequently employed models are the Technology Acceptance Model (Davis 1989) and the Task-Technology Fit Model (Goodhue 1995). In addition to these models, a number of constructs have been suggested and developed to help explain user choices, e.g., Computer Self-efficacy (Compeau and Higgins 1995).

These largely independent streams of research led to our interest in explicitly exploring the similarities and differences among models and constructs that help MIS researchers understand users' choices about the software they use. Research on integrating these models and constructs is beginning to appear in the literature. For example, the call for research on the antecedents of the TAM external constructs, Perceived Usefulness and Perceived Ease of Use, by Venkatesh and Davis (1996) has generated follow-on studies (e.g., Venkatesh 2000). Similar explorations of the TTF model have also appeared in the literature, (e.g., Goodhue and Thompson 1995, Dishaw and Strong 1998a, Dishaw and Strong 1998c). A combined Technology Acceptance and the Task-Technology Fit Model has also been developed and tested (Dishaw and Strong 1999). In this paper, we are extending this line of research by investigating the relationship between Computer Self-efficacy (CSE) and the combined Technology Acceptance and the Task-Technology Fit Model. More generally, we are collecting a dataset that includes TTF, TAM, and CSE constructs. This dataset will provide a sample for testing empirically and independently several of the extended TAM, TTF, and Self-efficacy models and relationships that have appeared in the literature.

Previously Developed Models and Constructs

Before presenting our proposed model, we review the literature on existing models and constructs for studying the choices of users about the software to utilize.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (Davis 1985, Davis et al. 1989) is a specific adaptation of the Theory of Reasoned Action (TRA) model (Ajzen and Fishbein 1980) to the study of Information Technology (IT) usage. The TRA and its successor, the Theory of Planned Behavior (TPB) (Ajzen 1985), are well known, and have been widely employed in the study of specific behaviors (Ajzen and Fishbein 1980). In general, these theories (TRA, TAM) state that a behavior is determined by intention to perform the behavior. Actual behavior and intention have been found to be highly correlated (Davis 1985, Fishbein and Ajzen 1980). Intention, itself, is determined by attitude towards the behavior.

Davis' research, in essence, examines the external variables that determine or influence attitude towards IT use. The TAM identifies Perceived Ease of Use and Perceived Usefulness as key independent variables (Davis 1989). Perceived Ease of Use also influences Perceived Usefulness. The TAM includes the very important assumption that the behavior is volitional, which is to say voluntary or at the discretion of the user. The TAM has been tested in several studies of IT use (Adams et al. 1992, Davis et al. 1989, Mathieson, 1991, Straub et al. 1997).

Task-Technology Fit Model (TTF)

The core of a Task-Technology Fit Model is a formal construct known as Task-Technology Fit (TTF), which is the matching of the capabilities of the technology to the demands of the task, that is, the ability of IT to support a task (Goodhue and Thompson 1995). TTF models have four key constructs, Task Characteristics, Technology Characteristics, which together affect the third construct Task-Technology Fit, which in turn affects the outcome variable, either Performance or Utilization. TTF models posit that IT will be used if, and only if, the functions available to the user support (Fit) the activities of the user. Rational, experienced users will choose those tools and methods that enable them to complete the task with the greatest net benefit. Information Technology that does not offer sufficient advantage will not be used.

A common addition to a TTF model is Individual Abilities (Goodhue 1988, Goodhue and Thompson 1995). The inclusion of Individual Abilities is supported by both Work Adjustment Theory from which TTF was originally derived and recent MIS studies in which Experience with particular IT is generally associated with higher Utilization of that IT (Guinan et al. 1997, Thompson et al. 1994).

Relationship between TTF and TAM

These two major models, the Technology Acceptance Model (Davis 1989) and the Task-Technology Fit Model (Goodhue 1995) were combined into the comprehensive model shown in Figure 1 (Dishaw and Strong 1999). The general argument for combining the models is that they capture two different aspects of users' choices to utilize IT. TAM, and the attitude/behavior models on which it is based, assume that users' beliefs and attitudes toward a particular IT largely determine whether users exhibit the behavior of using the IT. Critics note that users regularly use IT that they do not like because it improves their job performance. TTF models take a decidedly rational approach by assuming that users choose to use IT that provides benefits, such as improved job performance, regardless of their attitude toward the IT (Goodhue 1995). Both aspects, attitude toward the IT and rationally determined expected consequences from using the IT, are likely to affect users' choices to use IT.

In the combined model, TTF constructs both serve as antecedents to the TAM model constructs, Perceived Usefulness and Perceived Ease of Use, and also as direct effects on software Utilization. As antecedents, the combined model represents another study that helps researchers understand the TAM antecedents, which in turn helps managers understand how to provide software that is perceived to be useful and easy to use. As direct effects, Task Characteristics and Task-Technology Fit from the TTF model directly affect Utilization. This is a major contribution of TTF to the combined model, since TAM only indirectly considers how the software tool supports the user's task through the Perceived Usefulness construct. That is, TAM focuses much more on the technology than the ability of the technology to support users as they perform their tasks, which is the core focus of the TTF model.

The result of combining the two models provided a better model of IT utilization than either an attitude or a fit model provided separately (Dishaw and Strong 1999). There was a strong and statistically very significant relationship between Task-Technology Fit (TTF) and Perceived Ease of Use, and through Perceived Ease of Use to Perceived Usefulness, both predictors of tool utilization in the Technology Acceptance Model. As part of the research described in this paper, we will re-test this model with a new dataset from different respondents using different tools for different tasks.
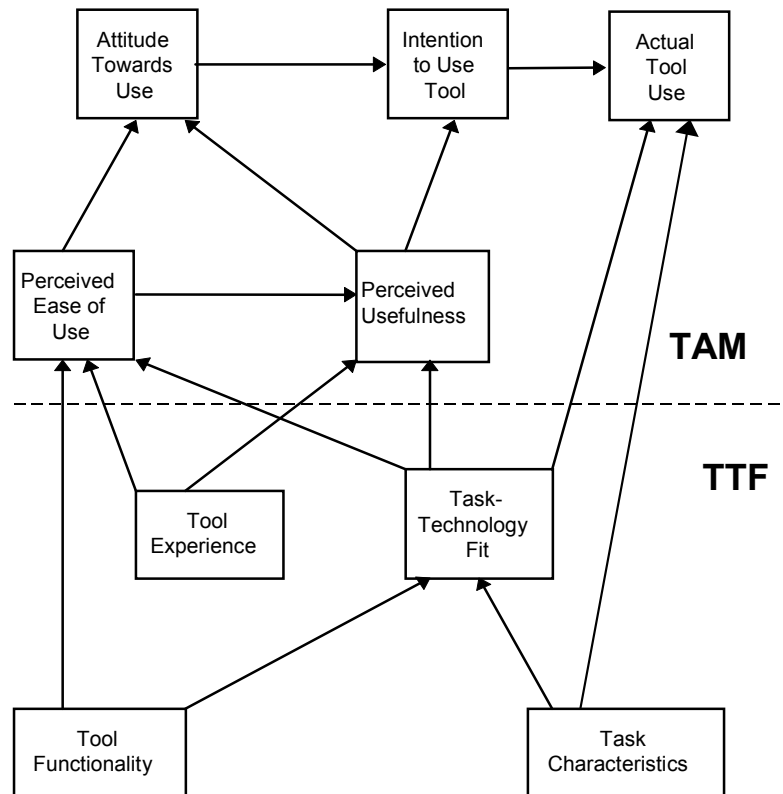
Figure 1. Integrated TAM/TTF Model
(from Dishaw and Strong 1999)

Computer Self-Efficacy

Research on IT utilization behavior has a number of research streams other than TAM and TTF, e.g., a model tailored for personal computing (Thompson et al. 1991). Notable in this area is the study of Perceived Computer Self-Efficacy (Compeau and Higgins 1995), which examines users' beliefs regarding their ability to perform specific tasks using a software package. Computer Self-Efficacy (CSE) may be defined as a judgment of one's ability to use a computer. Compeau and Higgins (1995) developed a 10-item, single factor measure of CSE, which has been used in several follow-on studies (Compeau et al. 1999, Agarwal et al. 2000, Venkatesh 2000).

The CSE construct is a specialized definition of Self-efficacy, i.e., a person's belief in their ability to accomplish a specific task (Compeau and Higgins 1995). Bandura (1986) developed the concept of Self-efficacy from the Social Cognition literature. There are three general dimensions of Self-efficacy, magnitude of the ability, certainty or strength of the belief, and generalizability of the ability. In the literature, many studies only measure strength or certainty (e.g., Murphy et al. 1989, Lent et al. 2001, Pajares and Miller 1997), some also measure magnitude (e.g., Locke et al. 1984), and few if any measure generalizability.

Self-efficacy is not a measurable concept at a general level since abilities are domain specific. Thus, new measures of Self-efficacy must be developed for each different application of the construct. Compeau and Higgins (1995) conceptualization of CSE provides a measure that is specific to computer system usage skills, but sufficiently general to be applied to any computer system. As a result, it is commonly used in Computer Self-efficacy studies, and is the approach taken in the study reported in this paper.

Others argue that specific measures tailored to specific computer systems should be included and propose a construct more narrowly defined as the ability to use or employ specific software (Venkatesh and Davis 1996). For example, one study uses both the general CSE and develops specific CSE measures for Windows 95 and Lotus 123 (Agarwal et al. 2000). Tailoring to a

specific system has the disadvantage of lack of generalizability of the research. A solution is the approach of Murphy et al. (1989), who developed a 32-item comprehensive set of computer skills consisting of three factors, beginning skills, advanced skills, and mainframe skills. This latter approach can provide more useful information to managers assigning employees to tasks.

Since Self-efficacy is defined as a person's belief in their ability to accomplish a specific task, the outcome variable in models employing a Self-efficacy construct is often some measure of Task Performance. Other variables are also included, e.g., Goals and Abilities, to test the role of Self-efficacy in explaining Task Performance. A variety of studies have supported Bandura's assertion that Self-efficacy is a key determinant of Performance (e.g., Locke et al. 1984). Self-efficacy constructs have been widely used in the educational literature to study academic performance (Christensen et al. 2002, Zimmermain et al. 1992, Multon et al. 1991, Schunk 1991), choices of educational options and careers (Lent et al. 1986, Lent, et al. 2001), mathematical problem-solving performance (Hackett and Betz 1989, Pajares and Kranzler 1995, Pajares and Miller 1997). In the IT literature, CSE has been studied as the antecedent of Perceived Ease of Use in the TAM model (Venkatesh and Davis 1996, Fenech 1998). CSE has also been linked to the User Competence construct (Marcolin et al. 2000).

According to Bandura, Self-efficacy is affected by past experience, by observing others, by persuasion, and affective arousal, listed in order by magnitude of the effect (Murphy et al. 1989, Locke et al. 1984). Thus, Self-efficacy studies often include Experience as a control or as an antecedent of Self-efficiency. In the IT literature, Agarwal et al. (2000) included Relevant Prior Experience in their model explaining Ease of Use via CSE.

Proposed Model: TAM/TTF Model with Computer Self-Efficacy

While CSE has been tested as an antecedent of Perceived Ease of Use in the TAM, CSE has not been linked to the TTF model. TAM, TTF, and CSE have each individually demonstrated its power for increasing our understanding of why users choose to use software and how much they choose to use it. This helps managers in selecting software that will be of value to the organization, and in planning various activities such as training that will help users make productive use of the software. Beyond each individual model or construct, our understanding will deepen, as we understand how TAM, TTF, and CSE contribute to explaining performance and how they overlap. The link between CSE and Perceived Ease of Use can help managers understand how to increase Perceived Ease of Use, and thus acceptance of a new technology being brought into the organization. With the motivation of increasing understanding of user choices about software, we are exploring potential links between CSE and the TTF model.

In the TTF model, a common added construct is Individual Abilities (Goodhue 1988, Goodhue and Thompson 1995). Individual Abilities cover a wide range of possible constructs. In tests of TTF models, Individual Abilities, operationalized as Computer Literacy, negatively affected perceived Fit between task and technology (Goodhue 1995) and, operationalized as Experience with the particular IT, positively affected Utilization (Dishaw and Strong 1998b). While Computer Experience and Computer Literacy are not the same as Computer Self-efficacy, they are related and are each possible operationalizations of the Individual Abilities construct.

In the combined TAM/TTF model, an individual ability added to the model was the user's Experience with the tool, which was significantly and positively related to both Perceived Ease of Use and Perceived Usefulness (Dishaw and Strong 1999). The argument is that with increased knowledge through experience, a tool will be perceived as easier to use. The experienced user will also see more potential uses of the tool as they become more experienced, and thus should also perceive a software tool as more useful. Current IT literature has shown that CSE affects Perceived Ease of Use and is affected by Experience. This relationship needs to be tested in the context of the TTF model. We also will explore the relationship to Perceived Usefulness. In the combined model, Experience affects Perceived Usefulness, but in the reported literature CSE affects Perceived Usefulness only through Perceived Ease of Use.

The goal of this paper is to explore these relationships to determine whether or not the addition of CSE to the integrated TAM/TTF, in place of or in addition to Experience, increases its predictive or explanatory power. In the combined TAM/TTF model, we have added Computer Self-efficacy. A portion of the overall revised model is shown in Figure 2.

Research Method

To test this model, we employ the standard survey questions for the TTF, TAM, and CSE. The Computer Self-Efficacy (CSE) items (Compeau and Higgins 1995) were added to the instruments used to assess the TTF and TAM constructs. TTF is computed from measures of task and technology characteristics using a technique developed in Dishaw and Strong (1998c).
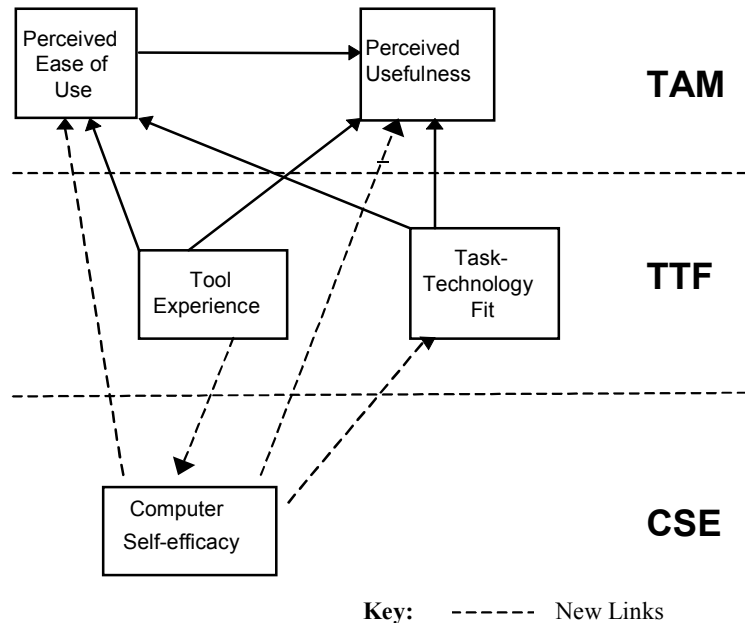
Figure 2. Adding CSE to Combined TAM/TTF Model
(only a portion of the overall model is shown)

Students who are using tools such as Microsoft Access, SPSS, Microsoft Project, ProModel, or a CASE tool are being surveyed this semester upon completion of routine modeling assignments. At least 100 data points are being obtained. After we complete data collection, path analysis will be applied to these data using Amos 4.0 as supplied by SPSS. Before testing the proposed model, we will first re-test the component models. Specifically, we will test the following series of models using our dataset:

1. TAM
2. TAM plus CSE
3. TAM plus CSE plus Experience
4. TIF
5. TTF plus CSE
6. Combined TAM/TTF
7. Combined TAM/TTF with CSE
8. Expected Results

Preliminary results from this analysis will be ready for presentation at the conference. Based on the literature and prior experience with the models, we expect that one or more of the TAM/TTF constructs will be significantly correlated with CSE. This study will also serve to replicate the original test of the combined TAM/TTF model.

Companies spend a lot of money on software, much of which is underutilized. The practical contribution of this research is a better understanding of the antecedents of software use. If managers had a better understanding of why users choose to use software and how frequently they are willing to use it, they could take actions to promote better utilization of the software that the organization has acquired. Understanding the antecedents of use would provide great value to organizations.

References

Adams, D.A., Nelson, R.R., and Todd, P.A. "Perceived Usefulness, Ease of Use, and Usage of Information Technology: A Replication," MIS Quarterly (16:2), 1992, pp. 227-247.

Agarwal, R., Sambamurthy, V., Stair, R. "The Evolving Relationship Between General and Specific Computer Literacy – An Empirical Assessment," Information Systems Research (11:4), 2000, pp. 418-430.

Ajzen, I. "From Intentions to Actions: A Theory of Planned Behavior," In Action Control: From Cognition to Behavior, Kuhl, J. and Beckmann, J., Editors, New York: Springer Verlag, pp. 11-39, 1985.

Ajzen, I. and Fishbein, M. Understanding Attitudes and Predicting Social Behavior, Englewood Cliffs, NJ: Prentice Hall, 1980.

Bandura, A. Social Foundations of Thought and Action: A Social Cognitive Theory, Englewood Cliffs, NJ: Prentice-Hall, 1986.

Christensen, T. E., Fogarty, T. J., and Wallace, W. A. "The Association between the Directional Accuracy of Self-efficacy and Accounting Course Performance," Issues in Accounting Education (17:1), 2002, pp. 1-26.

Compeau, D.R. and Higgins, C.A. "Computer Self-Efficacy: Development of a Measure and Initial Test", MIS Quarterly (19:2), 1995, pp. 189-211.

Compeau, D., Higgins, C.A., and Huff, S. "Social Cognitive Theory and Individual Reactions to Computing Technology: A Longitudinal Study," MIS Quarterly (23:2), June 1999, pp. 145-158.

Davis, F.D., Jr., A Technology Acceptance Model for Empirically Testing New End-User Systems: Theory and Results, Unpublished Doctoral Dissertation, Massachusetts Institute of Technology, 1985.

Davis, F.D. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," MIS Quarterly (13:3), 1989, pp. 318-339.

Davis, F.D., Bagozzi, R.P., and Warshaw, P.R. "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models," Management Science (35:8), 1989, pp. 982-1003.

Dishaw, M.T. and Strong, D.M. "Assessing Software Maintenance Tool Utilization Using Task-Technology Fit and Fitness-for-Use Models," Journal of Software Maintenance: Research and Practice (10:3), 1998a, pp. 151-179.

Dishaw, M.T. and Strong, D.M. "Experience as a Moderating Variable in a Task-Technology Fit Model," In Fourth Americas Conference on Information Systems, Baltimore, MD: Association for Information Systems, 1998b, pp. 722-724.

Dishaw, M.T. and Strong, D.M. "Supporting Software Maintenance with Software Engineering Tools: A Computed Task-Technology Fit Analysis," Journal of Systems and Software 44, 1998c, pp. 107-120.

Dishaw, M.T. and Strong, D.M. "Extending the Technology Acceptance Model with Task-Technology Fit Constructs," Information and Management (36:1), 1999, pp. 9-21.

Fenech, T. "Using Perceived Ease of Use and Perceived Usefulness to Predict Acceptance of the World Wide Web," Computer Networks and ISDN Systems, (30:1-7), 1998, pp. 629-630.

Goodhue, D.L. Supporting Users of Corporate Data: The Effect of I/S Policy Choices, Unpublished Doctoral Dissertation, Massachusetts Institute of Technology, 1988.

Goodhue, D.L. "Understanding User Evaluations of Information Systems," Management Science (41:12), 1995, pp. 1827-1844.

Goodhue, D.L. and Thompson, R.L. "Task-Technology Fit and Individual Performance," MIS Quarterly (19:2), 1995, pp. 213-236.

Guinan, P.J., Cooprider, J.G., and Sawyer, S. "The Effective Use of Automated Application Development Tools," IBM Systems Journal (36:1), 1997, pp. 124-139.

Hackett, G. and Betz, N.E. "An Exploration of the Mathematics Self-Efficacy/Mathematics Performance Correspondence," Journal for Research in Mathematics Education (20:3), 1989, pp. 261-273.

Lent, R.W., Brown, S.D., Brenner, B., Chopra, S.B., Davis, T., Talley, R., and Suthakaran, V. "The Role of Contextual Supports and Barriers in the Choice of Math/Science Educational Options: A Test of Social Cognitive Hypotheses," Journal of Counseling Psychology (48:4), 2001, pp. 474-483.

Lent, R.W., Brown, S.D., and Larkin, K.C. "Self-Efficacy in the Prediction of Academic Performance and Perceived Career Options," Journal of Counseling Psychology (33:3), 1986, pp. 265-269.

Locke, E. A., Frederick, E., Lee, C., and Bobko, P. "Effect of Self-Efficacy, Goals and Task Strategies on Task Performance," Journal of Applied Psychology (69:2), 1984, pp. 241-251.

Marcolin, B.L., Compeau, D.R., Munro, M.C., Huff, S. L. "Assessing User Competence: Conceptualization and Measurement," Information Systems Research (11:1), 2000, pp. 37-60.

Mathieson, K. "Predicting User Intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior," Information Systems Research (2:3), 1991, pp. 173-191.

Multon, K.D., Brown, S.D., and Lent, R.W. "Relation of Self-Efficacy Beliefs to Academic Outcomes: A Meta-Analytic Investigation," Journal of Counseling Psychology (38:1), 1991, pp. 30-38.

Murphy, C.A., Coover, D., and Owen, S.V. "Development and Validation of the Computer Self-Efficacy Scale," Educational and Psychological Measurement 49, 1989, pp. 893-899.

Pajares, F. and Kranzler, J. "Self-Efficacy Beliefs and General Mental Ability in Mathematical Problem-Solving," Contemporary Educational Psychology 20, 1995, pp. 426-443.

Pajares, F. and Miller, D.M. "Mathematics Self-Efficacy and Mathematical Problem-Solving: Implications of Using Different Forms of Assessment," Journal of Experimental Education (65:3), 1997, pp. 213-228.

Schunk, D.H. "Self-Efficacy and Academic Motivation," Educational Psychologist (26:3,4), 1991, pp. 207-231.

Straub, D., Keil, M., and Brenner, W. "Testing the Technology Acceptance Model Across Cultures: A Three Country Study," Information & Management (33:1), 1997, pp. 1-11.

Thompson, R.L., Higgins, C.A., and Howell, J.M. "Personal Computing: Toward a Conceptual Model of Utilization," MIS Quarterly 15, 1991, pp. 125-143.

Thompson, R.L., Higgins, C.A., and Howell, J.M. "Influence of Experience on Personal Computer Utilization: Testing a Conceptual Model," Journal of Management Information Systems (11:1), 1994, pp. 167-187.

Venkatesh, V. "Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model," Information Systems Research (11:4), December 2000, pp. 342-365.

Venkatesh, V. and Davis, F.D. "A Model of the Antecedents of Perceived Ease of Use: Development and Test," Decision Sciences (27:3), Summer 1996, pp. 451-481.

Zimmerman, B.J., Bandura, A., and Martinez-Pons, M. "Self-Motivation for Academic Attainment: The Role of Self-Efficacy Beliefs and Personal Goal Setting," American Educational Research Journal (29:3), 1992, pp. 663-676.