Moderating Effects of ITV on Relationships among Learning and Performance in Management Education

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Abstract

This study advances management education research by empirically examining the effects of instructional technology on undergraduate management students' cognitive learning, affective learning, and performance. No significant differences were found in students' declarative knowledge, cognitive structures, academic task self-efficacy, and performance between a traditional human resources management course and a course delivered via interactive television (ITV). Instructional technology moderated the relationship between students' cognitive structures and performance. Students' prior college GPA, cognitive structures, and instructional technology explained 49.7% of the variance in students' performance. Only in the ITV course did changes in students' cognitive structures explain unique variance in performance. ITV students' cognitive structures partially mediated the effect of ability on performance. A three-way interaction among instructional technology, student performance, and general self-efficacy (GSE) significantly explained 34.6% of the variance in academic task self-efficacy. Only in the ITV course did GSE moderate the relationship between student performance and academic task self-efficacy. For ITV students with low GSE, academic task self-efficacy remained consistently high regardless of performance. For students with high GSE, academic task self-efficacy varied with performance. For both courses, students with low GSE had significantly higher levels of academic task self-efficacy than students with high GSE. **Instructional Technology, Cognitive Structures, Self-efficacy**

During the 1999-2000 academic year, eight percent of all undergraduate students in the United States participated in technology-mediated distance education. Thirty-seven percent of those students participated via live audio or television technologies, such as interactive television (ITV) (Sikora, 2002). While the body of research on instructional technology is substantial (Russell, 1999), research that specifically addresses fundamental learning processes is limited (Fulford & Sakaguchi, 2002). As students learn about a subject they acquire new information and gain knowledge about a particular domain. Since even naïve students have some preexisting knowledge related to a domain, integration of newly acquired information requires a reorganization of related knowledge stored in memory (Rumelhart & Ortony, 1977). Students' perceptions of their ability to perform specific tasks may also change during a course. The present study advances management education research by assessing students' cognitive learning and academic task self-efficacy in traditional and technology-mediated human resources management (HRM) courses.

Learning Criteria

In a Journal of Applied Psychology Monograph, Kraiger, Ford, and Salas (1993) advanced a theoretically based taxonomy of learning that, if widely adopted, would revolutionize training and education research. Table 1 lists the measures of learning used in this study that correspond to those advanced by Kraiger et al. The first column in Table 1 lists the terminology used here to describe each learning criterion, the center column describes the specific theoretical focus of each learning criterion and the last column lists common methodologies for the assessment of each learning criterion.

Insert Table 1 about here

In this framework, cognitive learning criteria are memory-based measures of the mental processes involved in acquiring, retaining, storing, and retrieving information. In general, the term declarative knowledge refers to the storage of basic facts and conceptual information (Bourne & Bunderson, 1963) in memory. Recognition and recall tests are measures of declarative knowledge that focus on the amount, accuracy, and accessibility of stored information (Kraiger et al., 1993). In Table 1, declarative knowledge refers to scores on recognition or recall tests administered during or immediately after a course. A second type of cognitive learning that occurs during education and training is the development of students' cognitive structures. Cognitive structures represent the organization of declarative knowledge concepts in memory. In Table 1, cognitive structure refers to students' implicit mental structures of the interrelationships among declarative knowledge concepts during or immediately after a course (Alba & Hasher, 1983; Goldsmith & Kraiger, 1997; McKeachie, Pintrich, Lin, Smith, & Sharma, 1986; Walsh, 1995). Measures of cognitive structures are derived through structural assessment procedures such as multidimensional scaling, cluster analysis, and Pathfinder network scaling (Schvaneveldt, 1990). Affective learning criteria are attitudinal or motivational states that influence behavior. Task self-efficacy (TSE) refers to a persons' perception of their capability to perform a specific activity. Task self-efficacy is a motivational state that influences task-related behavior.

Learning in Education and Training

Findings of education related increases in students' declarative knowledge are so robust that many people implicitly view information acquisition and learning as synonymous. Articles have been written identifying techniques for exposing management students to new information

(Bacon, Stewart, & Giclas, 1996; Brumagim, 1995), developing methods for assessing management students' acquisition of knowledge (Buskirk, Kruger, & Hazen, 1995; Cassidy, Constand, & Nicholson, 1992), and understanding the effects of student-centered pedagogies on management students' acquisition of knowledge (Watson, Kumar, & Michaelsen, 1993). Educational researchers consistently find that students in technology-mediated and traditional classrooms show no significant differences in their classroom performance (Alavi, Yoo, & Vogel, 1997; Berge & Mrozowski, 2001; Russell, 1999). Since student performance measures often contain a large declarative knowledge component, it appears that technology-mediated education is at least as effective as traditional courses in terms of students' acquisition of information.

For traditional courses conducted on college campuses, there also exists a coherent body of research on the development of students' cognitive structures. Goldsmith and colleagues (Acton, Johnson & Goldsmith, 1994; Goldsmith & Johnson, 1990; Goldsmith, Johnson & Acton, 1991) assessed changes in students' cognitive structures during traditional research methods and computer science courses. They reported that students' cognitive structures changed significantly during the courses, becoming more similar to the cognitive structures of instructors and experts. The similarity of students' cognitive structures to instructors or experts was predictive of student performance. In management education, the extant research on the development of students' cognitive structures is sparse. Two recent studies showed that the cognitive structures of undergraduate students in both instructor-centered and student-centered human resources management courses increased in similarity to experts, but that the degree of change did not reach statistical significance (Strbiak & Paul, 1997; 1998). Research on cognitive structure changes associated with technology-mediated education is also lacking. The most theoretically related studies of technology-mediated management education that located addressed students' personality types (Fornaciari & Matthews, 2000) and perceived learning (Arbaugh, 2001, 2002). We were unable to locate any research on technology-mediated education that directly related to students' cognitive structures.

Early management research on TSE emphasized its importance to learner performance in training and education (Gist & Mitchell, 1992). More recently, Cheng & Ho (2001) summarized the growing literature on the importance of post-training TSE to the transfer of training. They concluded that there was empirical support for six transfer relationships. In a laboratory experiment, post-training TSE was shown to uniquely predict performance adaptability to a more complex version of a trained task (Koslowski, Gully, Brown, Smith, & Nason, 2001). Saks (1995) contributed to our understanding by demonstrating the importance of post-training TSE on job related outcomes in organizations. He reported that TSE was a full mediator of the relationship between training and the ability to cope, and a partial mediator of relationships between training and newcomer adjustment, job satisfaction, organizational commitment, professional commitment, and intention to quit an organization. The importance of post-training TSE has been recognized by training researchers, but we were only able to locate one study of post-training TSE in management education. Lyden (1996) reported that for students in a business communication course, training performance during an oral presentation workshop predicted post-training TSE. Chen and Gully (1997) found that performance in undergraduate psychology courses was strongly related to final TSE for students low on general self-efficacy but consistently high for students high on general self-efficacy. The present study extends management education research by examining the effects of instructional technology on students' cognitive and affective learning, and relationships between student learning and performance.

Hypotheses

Interactive television (ITV), also referred to as interactive video conferencing (IVC), interactive video or video conferencing, is an instructional technology that utilizes two-way audio and video links to connect a home-site with multiple remote-sites. Microphones pick-up extraneous noise as well as students' comments, and multiple voices cancel each other out. Video signals are compressed and transmitted over digital telephone lines, resulting in loss of resolution and time delays in communication (Racine & Dilworth, 2000). These technical problems create challenges for instructors and students, yet the research to date indicates that in terms of student performance, technology-mediated education is at least as effective as traditional classroom instruction (Russell, 1999). However, it is not yet clear how theory-based measures of cognitive learning, affective learning, and student performance may differ among instructional technologies. Two null-hypotheses are advanced below to guide exploratory analyses and shed empirical light on these relationships.

Hypothesis 1a: The specific relationships among measures of students' cognitive learning, student performance, and student self-efficacy hypothesized below will not be significantly different between a technology-mediated course and a traditional course.

Hypothesis 1b: There will be no systematic differences in the amount of change in students' cognitive learning about human resources management between a technology-mediated course and a traditional course.

Previous research in the domain of management education documents increases in students' declarative knowledge in university management courses taught using a wide variety of instructional methods (Di Vesta, 1954; McKeachie et al., 1986; Watson, Michaelsen, & Sharp, 1991; Watson, et al., 1993). Strbiak and Paul (1998) reported statistically significant increases in declarative knowledge for both student-centered and instructor-centered pedagogies in undergraduate human resources management courses. Meta-analyses of training evaluation (Alliger & Janak, 1989; Alliger, Tannenbaum, Bennett, Traver, & Shotland, 1997) also cite numerous published studies that report increases in trainee's declarative knowledge. Findings from these two streams of research converge in the hypothesis that students will acquire new declarative knowledge during a traditional human resources management course and a course delivered via ITV.

Hypothesis 2: Students' declarative knowledge will increase during the course.

Goldsmith and colleagues (Goldsmith & Johnson, 1990; Goldsmith et al., 1991) documented changes in cognitive structures for students in an introductory psychological research methods course. Acton et al. (1994) showed that this change in students' cognitive structures was toward the development of expert cognitive structures. During management education and training activities, instructors' implicitly communicate their cognitive structures about the domain to students. Cognitive structures have been shown to be effective discriminators of experts and novices (Ericsson & Smith, 1991) and trainee and control groups (Kraiger & Salas, 1993). Paul & Strbiak (2001) reported a significant increase in the similarity of trainees' cognitive structures to trainers' cognitive structures during a supervisory management training program. Based on this prior research in education, psychology, and training, we expect that students' cognitive structures will change in a predictable direction during a traditional human resources management course and a course delivered via ITV.

Hypothesis 3: Students' cognitive structures will become more similar to experts' cognitive structures during the course.

Two meta-analyses of training evaluation (Alliger & Janak, 1989; Alliger et al., 1997) both reported positive correlations between trainees' declarative knowledge and training performance, with the most recent reporting a mean correlation of $\underline{r} = .18$. Paul & Strbiak (2001) reported that declarative knowledge accounted for 11.6% of the variance in training performance after statistically controlling for the effect of cognitive structures. In management education, student performance is often measured through examinations with large declarative knowledge components. In the present study, measures of declarative knowledge are independent of measures of student performance, so we expect to be able to confirm the relationship between declarative knowledge and student performance in a traditional human resources management course and a course delivered via ITV.

Hypothesis 4: Students' declarative knowledge will be predictive of student performance.

Numerous studies have documented the relationship between student/instructor cognitive structure similarity and higher final course grades (Diekhoff, 1983; Goldsmith & Johnson, 1990; Goldsmith, et al., 1991; Thro, 1978). Acton et al. (1994) showed that in the classroom expertise can be represented by instructors' cognitive structures. In a human resources management course, Strbiak and Paul (1998) found that cognitive structures of human resource management undergraduates were significantly related to a measure of performance that included a skill-based group performance component. However, this relationship was not apparent for an instructor-centered control group.

Kraiger, Salas, & Cannon-Bowers (1995) found that trainees' cognitive structures were significantly related to training performance. Paul and Strbiak (2001) reported that trainees' cognitive structures accounted for 29.3% of the variance in performance in a management training program after statistically controlling for declarative knowledge. Consistent with this previous research, we expected that those students who developed cognitive structures that were more similar to the cognitive structures of the HRM faculty would tend to receive better grades in a traditional human resources management course and a course delivered via ITV.

Hypothesis 5: Students' cognitive structures will be predictive of student performance.

While the hypotheses above specify relationships among student cognitions and performance, they do not adequately assess the effects of students' cognitive learning during a university course on their performance. Since measures of student performance in a specific knowledge domain are rarely available prior to scoring of course assignments and examinations, analysis of the relationship between students' incremental learning and course performance is uncommon. The independent measures of declarative knowledge used in this study will allow us to make statistical inferences about the effects of changes in students' declarative knowledge on their performance during a traditional human resources management course and a course delivered via ITV.

Hypothesis 6a: The change in students' declarative knowledge will be predictive of student performance.

Measures of students' cognitive structures in a specific knowledge domain prior to a university course are virtually non-existent. Paul and Strbiak (2001) recently reported that changes in trainees' cognitive structures accounted for 18.7% of the variance in performance during a management training program. The independent measures of students' cognitive structures used in this study will allow us to make statistical inferences about the effects of changes in cognitive structures on student performance during a traditional human resources management course and a course delivered via ITV.

Hypothesis 6b: The change in students' cognitive structures will be predictive of student performance.

Task self-efficacy is an important affective learning outcome in management education. TSE influences subsequent task performance and performance on similar tasks in other contexts, such as the workplace (Kraiger et al., 1993). TSE self-efficacy is believed to positively affect task performance by influencing individuals' choices of activities, effort, and persistence. TSE changes over time and is best predicted by previous performance on the task (Bandura, 1997).

In contrast to TSE, general self-efficacy (GSE) is viewed as a personality trait and therefore more stable. GSE has been defined as "one's belief in his or her capability to behave effectively in order to accomplish desired goals across different tasks and in different situations" (Chen & Gully, 1997, p. 19). GSE has been shown to moderate the relationship between training and the development of TSE, with training being more effective in increasing TSE for individuals with low GSE than those with high GSE (Eden & Aviram, 1993, Eden & Kinnar, 1991, Eden & Zuk, 1995). Chen and Gully (1997) reported that TSE for anticipated performance on a final exam was a function of previous performance for students with low GSE, but uniformly high for students with high GSE, regardless of previous performance. In the present study, we hypothesize that GSE will also moderate the relationship between performance and TSE for the task domain of academic performance.

Hypothesis 7: Students' general-self efficacy will moderate the relationship between students' performance in a course and their academic task self-efficacy.

Methods

Participants

Participants in this study were 70 undergraduate students enrolled in multiple sections of an undergraduate human resources management course offered by the Department of Management at a major southwestern state university during one semester. All sections utilized the same HRM textbook for course content. Volunteers were recruited by offering five extra-credit points to those students completing all Time 1 and Time 2 measures.

Traditional course. Thirty-three undergraduate students were enrolled in a traditional introductory course in human resources management. The pedagogy employed in the control group was lecture, supplemented by short films, class discussion, and some small group exercises and case analysis. All students remained enrolled in the course and received grades.

ITV course. Thirty-seven undergraduate students enrolled in four sections of a technology-mediated introductory course in human resources management. Seventeen students enrolled at the host-site on the main campus of the university. Twenty additional students enrolled at three remote-sites. Three students at the host-site dropped the course and all of the remaining thirty-four enrolled students received grades. Students at remote-sites were able to view the instructor, and other sites, on ITV monitors installed in classrooms at three rural branch campuses of the university. Remote-sites were also equipped with the technology to broadcast audio and video to all other sites, so that students in any location could interact with the instructor or students in any other locations. A technician was present at each site during every session to operate the ITV equipment and distribute and collect course materials. The course was interactive in that not only could students participate in discussions among all four sites, but interactions from all four sites were inherent components of the course.

Measures

Self-report questionnaire. Questionnaires were distributed during the last week of the course to collect students' self-report measures of college GPA, academic task self-efficacy, and general self-efficacy. Students were asked to fill in a blank with their overall college GPA prior to the current semester. Academic task self-efficacy was assessed with the question, "indicate how confident you are that you can successfully receive high grades in university courses" on a 10-point scale from no confidence to complete confidence. General self-efficacy was measured with seven positive items from a GSE scale then under development by Chen & Gully (1997). Cronbach's alpha was an acceptable 0.96 in this study.

Student performance. Actual final student performance in each course, reported as a percentage, was used as the measure of student performance. In the traditional course, performance was measured by three examinations and an optional final examination. Examinations in the traditional course consisted of 50 multiple-choice questions and one to three short answer essays. In the ITV course, performance was measured by two examinations, four quizzes, and an 8 to 10--page term paper. Examinations in the ITV group consisted of five essay questions. Quizzes consisted of three short answer questions. No multiple-choice or other "objective" questions were asked. Examinations and term papers were graded by instructors and teaching assistants.

Declarative knowledge. Students' declarative knowledge was measured with a 25-item multiple-choice test administered during the first week of the course (time 1), and the same test administered during the last week of the course (time 2). The declarative knowledge measures were recognition tests constructed from the test bank of a different HRM textbook than was being used in these courses.

Cognitive structures. Cognitive structures are always discussed relative to a domain of knowledge. This study examined students' cognitive structures about concepts related to human resources management. Students' cognitive structures were assessed during the first week of the course (time 1) and again during the last week of the course (time 2) using relatedness ratings between all possible pairs of eleven concepts. To create a representation for the organization of knowledge that would be diagnostic for expertise in the domain, concepts at multiple levels of abstraction were included and highly ambiguous concepts avoided (Cooke, 1989). Specific concepts were chosen based on subject matter experts' suggestions and our experience with HRM concepts used in previous studies (Strbiak & Paul, 1996, 1997, 1998). The eleven concepts selected (see Appendix A) were included in the Pathfinder Data Collection Instrument created especially for this stream of research. Pairwise comparisons were collected via this computer program and processed through the Pathfinder network scaling algorithm to create the Pathfinder networks used in the analyses.

Pathfinder (Schvaneveldt, 1990; Schvaneveldt, Durso, & Dearholt, 1989) is a network scaling algorithm based on graph theory. Pathfinder utilizes proximity data to create a network composed of nodes and links. Proximity data essentially represents the nearness, similarity, or relatedness of the pairs of concepts in a set. In a network resulting from application of the Pathfinder algorithm to proximity data, nodes represent concepts pertaining to the content area and links indicate strong relations in the concept set. Nodes that are directly linked are more highly related those that remain unlinked or are indirectly linked. Pathfinder starts out with a network where all nodes are completely linked. When the weighted link directly between two nodes is larger than the distance over an indirect path, the direct link is dropped from the network. The links that remain represent the shortest distances between concepts.

Two parameters are used in the Pathfinder algorithm: r and q. The r-parameter is used to define the Minkowski r-metric and compute the distance between two indirectly linked nodes. The weight of a path with weights $w_1, w_2, \ldots, w_k$ is:

$$W(P) = \left(\sum_{i=1}^{k} w_i^r \right)^{1/r}$$

Values for r can range from 1 to infinity. For r =1 the path weight is the sum of weights of each link along a path, for r = 2 the path weight is the Euclidean distance, and for r = ∞ the path weight is equal to the maximum weight of any link along the path. For ordinal data, such as those obtained from the relatedness ratings, the appropriate value is r = ∞ (Dearholt & Schvaneveldt, 1990). The q-parameter defines the limit on the number of links permitted in paths between nodes. Values of the q-parameter range from 2 to n-1 with n concepts in the set. When q is given the maximum value of n-1, the resulting network contains the fewest possible links, and the number of links in any given pathway is constrained only by the number of concepts in the network. It is common to use n-1 in generating networks because there is rarely a theoretical basis for constraining the length of any given path in an associative network. Additional details on Pathfinder network scaling can be found in Schvaneveldt et al. (1989) and Schvaneveldt (1990).

The Pathfinder algorithm allows cognitive structures to be compared and a measure of the similarity between two networks to be computed. This similarity measure is calculated by dividing the number of links in common between two networks (the intersection) by the total number of links in the two networks (the union). The probability that the intersection of two networks will be a particular number of links can be computed from the hypergeometric probability distribution, providing the number of common links expected by chance alone. This expected similarity is subtracted from the measure of observed similarity to yield an adjusted similarity measure that is interpretable relative to chance. Positive similarity measures indicate that two networks are more similar than chance, and negative similarity indicates that two networks are less similar than chance. It is important to note that the values of these similarity measures are small but extremely meaningful (e.g., see Gomez, Schvaneveldt, & Staudenmayer, 1996).

Referent cognitive structures. A referent expert cognitive structure was created by averaging cognitive structures of the four instructors who had recently taught human resources management at the university's main campus. Even among experts, cognitive structures differ with disciplinary perspectives, areas of specialty, and idiosyncratic differences. For this reason, Acton et al. (1994) recommend the use of multiple experts when creating a referent structure. The combination of these four experts provided a suitable referent for this study in that it represented the domain of human resources management from the perspective of the college faculty.

Results

Descriptive statistics and correlation tables for the traditional and ITV courses are presented in Table 2. Since assignment of students to groups was not random, between-group t-tests of the means of all measured independent variables were conducted. Two-tailed independent sample t-tests failed to identify any significant differences in means between the traditional and ITV courses ($\underline{\alpha} = .05$). For all variables, the 95% confidence intervals include zero. These results allow us to proceed with additional analysis based on the assumption that the participants in the traditional and ITV courses were not significantly different at Time 1.

Insert Table 2 about here

Hypothesis 1a was tested with between-group t-tests of the means of the dependent variables. Independent sample t-tests failed to identify any significant differences in means between the traditional and ITV course ($\alpha = .05$) on Time 2 measures of declarative knowledge, cognitive structures, academic task self-efficacy, and student performance. For all variables, the 95% confidence intervals include zero. Since the measure of student performance was based on instructor and teaching assistant scoring of student work, standardized student performance scores will be used for all subsequent analysis. Hypothesis 1a was supported.

Hypothesis 1b was tested with two-tailed between-group independent sample t-tests of declarative knowledge and cognitive structure residual gain scores (Kerlinger, 1986). No significant differences in residuals gains between-groups were identified for either declarative knowledge ($t(44) = 0.00$, $p = 1.0$) or cognitive structures ($t(38) = 0.00$, $p = 1.0$). Hypothesis 1b was supported.

Hypotheses 2 and 3 were tested via within-group paired t-tests of time 1 and time 2 measures of declarative knowledge and cognitive structures, respectively. One-tailed paired t-tests for increases in declarative knowledge were significant for both the traditional course ($t(17) = 3.46$, $p = .002$) and the ITV course ($t(27) = 3.08$, $p = .003$). Hypothesis 2 was supported. One-tailed paired t-tests for increases in cognitive structure similarity were significant for the traditional course ($t(17) = 1.78$, $p = .046$) but not for the ITV course ($t(21) = 0.97$, $p = .171$). However, the t-test of cognitive structure residual gain scores reported above under hypothesis 1b failed to find significant differences in amount of change between the traditional and ITV course, providing some support for hypothesis 3.

Tests of hypotheses 4 and 6a were combined using hierarchical multiple regression within the traditional and ITV courses. Declarative knowledge at time 2 should be more predictive of performance than declarative knowledge at time 1, so after initially entering students' college GPA as a control variable for ability, declarative knowledge at time 2 was entered, and then declarative knowledge at time 1. Neither the time 2 nor time 1 measures of declarative knowledge added significantly to the models' prediction of student performance for either course. To address the effects of changes in declarative knowledge, another regression equation was necessary for each group. In this equation, students' college GPA was initially entered as a control variable, declarative knowledge at time 1 was entered, and then declarative knowledge at time 2. Again, neither the time 2 nor time 1 measures of declarative knowledge added significantly to the models' prediction of student performance for either course. Hypotheses 4 and 6a were not supported for either course.

Tests of hypotheses 5 and 6b were combined using hierarchical multiple regression within the traditional and ITV courses. Cognitive structures at time 2 should be more predictive of performance than cognitive structures at time 1, so after initially entering students' college GPA as a control variable, cognitive structures at time 2 was entered, and then cognitive structures at time 1. For the traditional course, neither time 2 nor time 1 measures of cognitive structures added significantly to the models' prediction of student performance. For the ITV course, cognitive structures at time 2 significantly increased the prediction of student performance ($?R^2$ (15) = .192, p = .012). Time 2 cognitive structures remained significant with the further addition of time 1 cognitive structures ((β(14) = .504, p = .015). To address the effects of changes in cognitive structures, another regression equation was necessary for each group. In this equation, students' college GPA was initially entered as a control variable, cognitive structures at time 1 was entered, and then cognitive structures at time 2. Again, for the traditional course, neither time 2 nor time 1 measures of cognitive structures added significantly to the models' prediction of student performance. For the ITV course, cognitive structures at time 1 did not significantly increase the prediction of student performance, but addition of cognitive structures at time 2 significantly increased the prediction of student performance (?R^2 (14) = .191, p = .015). Thus, hypotheses 5 and 6b were not supported for the traditional course. For the ITV course, hypothesis 5 and 6b were supported.

The significance of between-group differences in relationships among cognitive structures and student performance can be explored with a single regression equation that includes the treatment variable (technology) and its interaction with cognitive structures at time 2. This analysis is presented in Table 3. The significant interaction indicates that technology moderates the relationship between cognitive structures at time 2 and performance. The relationship between cognitive structures and student performance is significantly different for the traditional and ITV courses ($\beta(29) = 1.001$, p = .024). The regression equation explains 49.7% of the variance in student performance across groups ($F(29) = 9.15$, p = .000). The form of this interaction is illustrated in Figure 1.

Insert Table 3 about here

Insert Figure 1 about here

Hypothesis 7 was also tested with a regression equation that included technology and its interaction with the hypothesized two-way interaction of student performance and GSE. This analysis is presented in Table 4. The regression equation explains a total 34.6% of the variance in students' academic task self-efficacy ($\underline{F}(39) = 5.65$, $\underline{p} = .001$). The three-way interaction of technology, student performance, and GSE is significant ($\beta(39) = -1.247$, $\underline{p} = .028$), explaining a unique 10.6% of the variance in academic task self-efficacy. The form of this interaction is illustrated in Figure 2. To further aid in interpretation, a median split based on GSE was performed and t-tests were conducted to evaluate differences in academic task self-efficacy. Students with low GSE had significantly higher ($\underline{t}(43) = 2.27$, $\underline{p} = .028$) mean scores on academic task self-efficacy ($\underline{M} = 8.50$, $\underline{SD} = 1.26$) than students with high GSE ($\underline{M} = 7.45$, $\underline{SD} = 1.59$).

Insert Figure 2 about here

Discussion

This study has yielded some new insights about the effects of instructional technology on relationships among undergraduate students' learning and performance in human resources management. In this study, no significant differences in students' cognitive learning and academic task self-efficacy were identified between the traditional course and the ITV course. Instructional technology was found to be a moderator of relationships between student learning and performance.

Statistically significant increases in students' declarative knowledge occurred for both courses. Students' cognitive structures became more similar to the expert referent in both courses, but cognitive structure changes failed to reach statistical significance for students in the ITV course. Unambiguous explanation of this finding not possible with the available data, but it may be that students in the ITV course did not manage their learning as well as students in the traditional course. Prior research has shown that technology-mediated instruction that increased learners' control over their learning processes resulted in less time on task and the use of fewer practice activities than for instructor delivered courses (Brown, 2001). If students are inexperienced or struggling with the content material then ITV can present some instructional limitations (Bates, 1995). The positive effects of adaptive guidance (Bell & Kozlowski, 2002) on trainees' self-regulation and performance highlight the importance of designing technology-mediated courses to open and maintain multiple lines of communication through the use of e-mail, telephone, fax, web pages, courier services, etc. (Bader & Roy, 1999).

Students' levels of declarative knowledge at time 2, and changes in their declarative knowledge from time 1, were not significantly related to student performance. This finding is worthy of note since our measures of declarative knowledge were created by independent researchers and not articulated with the course text, planned lecture material, or examination questions. The statistically significant increases in our measures of declarative knowledge predicted by hypothesis 2 provide some evidence for the validity of our measures. The lack of a relationship between declarative knowledge and student performance indicates that measures of student performance were not sensitive to differences in students' general knowledge of HRM. This could occur if student performance scoring emphasized higher-level cognitive processing objectives such as application, analysis, synthesis, or evaluation. Based on our inquiry into examination scoring for these courses, the most plausible explanation is that student performance was scored so specifically that knowledge of HRM above and beyond what was requested by examination questions did not improve student performance.

Instructional technology was a significant moderator of the relationship between students' cognitive structures about human resources management and their performance. In the traditional course, neither students' cognitive structures at time 2 nor changes in students' cognitive structures were predictive of student performance. In the ITV course, changes in students' cognitive structures explained an additional 19.1% of the variance in student performance after statistically controlling for prior GPA. Students' cognitive structures partially mediated the effect of ability on performance, consistent with recent research (Day, Arthur, & Gettman, 2001). The results for the ITV course were as hypothesized, but the lack of a relationship between students' cognitive structures and performance for the traditional course were unexpected. The most plausible explanation for this difference between courses is related to differences in student performance measures, rather than to instructional technology per se. In the traditional course, student performance consisted of scores on examinations with large declarative knowledge (i.e., multiple-choice) components. In the ITV course, student performance was measured exclusively via essay examinations and a term paper. Writing essays and papers requires students to choose the information to include and to organize that information for presentation. Therefore, essay examinations include both declarative knowledge and knowledge organization components. The scoring of the performance measure for the ITV course was probably more sensitive to students' organization of knowledge than examinations in the traditional course. This is consistent with prior research on the sensitivity of essay examinations to knowledge organization (Diekhoff, 1983; Naveh-Benjamin, McKeachie, Lin, & Tucker 1986; Stanners, Brown, Price, & Holmes, 1983).

We also found a three-way interaction among instructional technology, student performance, and resultant academic task self-efficacy. A two-way interaction between student performance and GSE was predicted by hypothesis 7. In the traditional course, the hypothesized two-way interaction was not significant. In the ITV course, GSE moderated the relationship between student performance and academic task self-efficacy. We expected student performance to have more impact on academic task self-efficacy for students with low GSE than for students with high GSE. The second graph in figure 2 shows that for the group of high GSE students in the ITV course, students with higher performance had higher academic task self-efficacy. For the group of low GSE students, regardless of the level of performance, students' academic task self-efficacy remained consistently high. Chen and colleagues (Chen & Gully 1997; Chen, Gully, & Eden, 2001) found that students with low GSE and low performance had low TSE, whereas students with high GSE had consistently high TSE regardless of performance. One possible explanation for this reversal of results may be related to differences in anchoring (Lyden, 1996) between the student samples. Many of the students at the university where our study was administered are from families of historically low socioeconomic status and are often the first members of their families to attend college. Low GSE students in this population may have been satisfied with average, or lower than average, performance in these college courses. If they considered passing grades in these college courses as "high grades," this may have led to high TSE ratings. This would indicate that students' believed that they could do as well in future college courses and ultimately receive a college degree. Since TSE was measured at the end of the course, low GSE students may have already increased their TSE based on prior performance feedback and high GSE students may have already downwardly adjusted optimistically high TSE levels based on performance feedback from previous exams. However, even if this is the case it is not clear why low GSE students in the traditional course experienced supplementation of TSE rather than the moderation seen in the ITV course.

Limitations

While the present study sheds new light on learning and performance in technology-mediated management education, there are some areas of concern. The first, and most important, has to do with the operational definition and measurement of cognitive structures. While numerous research studies have provided evidence for the validity of Pathfinder networks (Schvaneveldt, 1990), concerns remain about convergent and discriminant validity of cognitive structure measures (Day et al., 2001; Dorsey, Campbell, Foster, & Miles, 1999). Although cognitive structure measurement in education dates to 1956 (Runkel), the state-of-the-art in the measurement of cognitive structures might still be best described as an art. At this point in the development of the science, empirical results that differ from theory-based hypotheses should be viewed tentatively. Second, while various measures have provided valid assessments of TSE (Tierney & Farmer, 2002), the specific TSE measure used in this study may have been particularly vulnerable to anchoring effects. Third, a single precise measure of student performance may have better elicited the theoretically predicted relationships with declarative knowledge and cognitive structures. Lastly, the generalizability of the present study is limited due to the small sample of students from only five sections of human resources management at one university.

Conclusions

The present study advances management education research by explicating relationships among students' cognitive learning, academic task self-efficacy, and performance in traditional and technology-mediated human resources management courses. No significant differences were identified for students' declarative knowledge, cognitive structures, academic task self-efficacy, and performance. Declarative knowledge and changes in declarative knowledge were not related to student performance. Instructional technology did moderate relationships between multiple measures of student learning and performance.

Perhaps the most important implication of this research is that adequate explanations of instructional technology moderation will require future studies to: 1) employ precise measures of learning and performance constructs, and 2) include a sufficient subset of relevant constructs from the emerging nomological network. These variables include, but are not limited to, precise measures of learning outcomes (Kraiger et al., 1993), transfer outcomes (Cheng & Ho, 1999), training motivation (Colquitt, LePine, & Noe, 2000), individual differences (Mathieu & Martineau, 1997), instructor interactional strategies (Fulford & Sakaguchi, 2002), training strategy (Kozlowski et al., 2001), learner strategies, choices, and behavior (Brown, 2001; Elliott, McGregor, & Gable, 1999; Engelbrecht & Fischer, 1995), learner goal orientation and content goals (Brett & VandeWalle, 1999), situational influences (Mathieu & Martineau, 1997), pretraining context (Quinones, 1995), pre-practice, practice, and post-practice conditions (Cannon-Bowers, Rhodenizer, Salas, & Bowers, 1998), and transfer climate (Tracey, Tannenbaum, & Kavanagh, 1995).

Throughout the years, select higher education researchers have addressed college student learning with theory-based research designs and rigorous experimental methods (McKeachie et al., 1986). Yet, contemporary higher education research in general, and academic management education research in particular, has rarely built on these foundations. After almost forty years of complacent acceptance of Kirkpatrick's (1959a, 1959b, 1960a, 1960b) taxonomy, a community of practice composed primarily of psychologists is now breaking new theoretical and methodological ground in training and training evaluation research. Now is the time for those of us who research management education and development to seize this opportunity and build our castles on these firm foundations.

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Appendix

Concepts Used to Measure Cognitive Structures for the Domain of Human Resources Management

affirmative action	compensation
discrimination	benefits
selection	merit pay
assessment center	grievance
training	safety
performance appraisal	

Table 1

Management Education Learning Criteria Measured in this Study

Learning Criteria	Foci of Evaluation	Common Methodologies
	Cognitive Learning	
Declarative Knowledge	Acquisition of information in the knowledge domain during or immediately after course	Multiple-choice tests, fill-in-the-blank, matching, short answer tests
Cognitive Structure	Relationships among concepts in memory during or immediately after course	Pathfinder, MDS[a], or other structural assessment methods
	Affective Learning	
Task Self-Efficacy	Perceived performance capabilities for a specific activity during or immediately after course	Self-report measures

[a] MDS = Multidimensional Scaling.

Table 2

Descriptive Statistics and Correlation Tables for Traditional and ITV Courses

	N	M	SD	1	2	3	4	5	6	7	8	SD	M	N	
1. College GPA	22	3.28	0.47	-	.057	-.071	-.338	.244	.512*	.313	.422	0.39	3.09	16	College GPA
1. Declarative Knowledge Time 1	34	11.41	3.15	.295	-	.305	-.059	.011	.248	.180	-.044	2.36	10.00	24	Declarative Knowledge Time 1
1. Declarative Knowledge Time 2	28	13.54	2.99	.375	.310	-	.004	.259	.288	.122	-.085	2.68	12.83	18	Declarative Knowledge Time 2
1. Cognitive Structure Time 1	31	.1044	.0676	.279	.205	.363	-	.232	-.387	-.383	-.151	.0618	.0672	22	Cognitive Structure Time 1
1. Cognitive Structure Time 2	22	.1060	.0679	.492*	.234	.333	.408	-	.228	-.316	.109	.0934	.0996	18	Cognitive Structure Time 2
1. Student Performance	34	85.74	9.96	.507*	.328	.381*	-.281	.428*	-	-.115	.649**	12.16	82.76	33	Student Performance
1. General Self-Efficacy	27	4.16	0.916	-.256	.242	.250	.293	-.188	-.126	-	-.371	0.908	4.26	18	General Self-Efficacy
1. Academic Task Self-Efficacy	28	7.93	1.33	.104	-.141	-.102	-.045	.421	.269	-.249	-	1.85	7.61	18	Academic Task Self-Efficacy

Note: *$p<0.05$, **$p<0.01$, ***$p<0.001$, Lower Triangle = ITV Course, Upper Triangle = Traditional Course.

Table 3

Student Performance Regressed on Technology and Cognitive Structures at Time 2

	Student Performance					
	β	T	R	R^2	Adjusted R^2	Change in R^2
Step 1						
College GPA	.638	4.469***				
Technology	-.148	-1.037	.626***	.392***	.353***	
Step 2						
College GPA	.633	3.668**				
Technology	-.138	-0.931				
Cognitive Structure Time 2	.300	2.118*	.686***	.471***	.418***	.079*
Step 3						
College GPA	.455	3.203**				
Technology	-.522	-2.503*				
Cognitive Structure Time 2	-.532	-1.425				
Technology X Cognitive Structure Time 2	1.001	2.383*	.747***	.558***	.497***	.087*

†p ≤ .10, *p ≤ .05, **p ≤ .01, ***p ≤ .001, N = 34.

Table 4

Academic Task Self-Efficacy Regressed on Student Performance, General Self-Efficacy, and Technology

	Academic Task Self-Efficacy					
	β	T	R	R^2	Adjusted R^2	Change in R^2
Step 1						
Performance	-1.160	$-1.935^{\dagger}$				
GSE	-.402	-2.870^{*}				
Performance X GSE	1.523	2.555^{*}	$.560^{**}$	$.314^{**}$	$.264^{**}$	
Step 2						
Performance	-1.168	-2.068^{*}				
GSE	-.425	-3.194^{**}				
Performance X GSE	2.795	3.572^{**}				
Technology	.383	2.473^{*}				
Performance X GSE X Technology	-1.247	-2.289^{*}	$.648^{*}$	$.420^{*}$	$.346^{*}$	$.106^{*}$

$^{\dagger}p \leq .10$, $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$, N = 34.

Figure 1. Two-way interaction of instructional technology and students' cognitive structures at time 2 on standardized performance

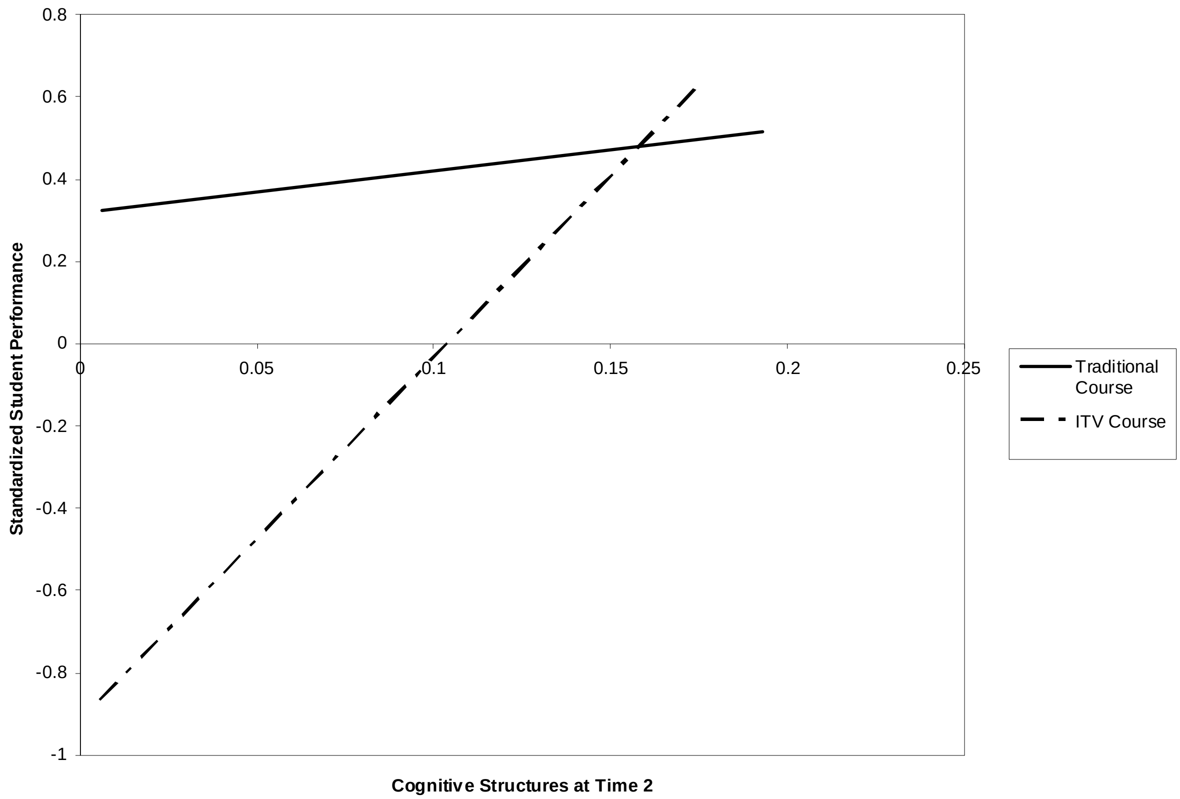

Figure 2. Three-way interaction of instructional technology, student performance, and students' general self-efficacy on academic task self-efficacy