The Effects of Videoconferencing, Class Size, and Learner Characteristics on Training Outcomes

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Abstract

We examined direct and interaction effects of learners' characteristics (cognitive ability, prior knowledge, prior experience, and motivation to learn) and classroom characteristics (videoconferencing and class size) on learning from a 16-week course. A 2x2 quasi-experimental design varied the class size between large (~ 60 students) and small (~ 30 students) and between traditional classes with the instructor always present and classes taught using a videoconferencing system with the instructor present at each site every other week. Theory regarding instructor immediacy was used to predict that larger and videoconferenced classes would have negative effects on learner reactions and learning, but that highly motivated learners would overcome the negative effects on learning. Interactions between videoconferencing and motivation to learn, and class size and motivation to learn, were found in support of the theory. Research and practice implications are discussed.

The Effects of Video Conferencing, Class Size, and Learner Characteristics on Training Outcomes

Videoconferencing is becoming more widespread as a training medium (Sugrue, 2003). Advantages of videoconferencing relative to traditional classroom instruction include greater convenience for people at remote sites and reduced travel expenses. Relative to other forms of distance training, videoconferencing has the advantage of having higher levels of synchronous, verbal interaction between the instructor and learners. Because of the possibility for this type of 2-way interaction, videoconferencing is considered the distance training method closest to classroom instruction (Moore & Kearsley, 1996), and is being used by many corporations and universities (Webster & Hackley, 1997).

Research to date has provided few prescriptions about when videoconferencing is appropriate. Most models of training effectiveness suggest that both situational and individual factors have effects on training outcomes (Mathieu, Tannenbaum, & Salas, 1992). Yet, few situational and individual factors have been examined in research that compares videoconferencing to other means of delivering training. As a result, it is unclear under what circumstances, and for which learners, videoconferencing would be an appropriate delivery technology. Reviews of delivery technology research revealed that many studies in this area are case studies, and thus it is difficult to draw conclusions about causal relationships (Russell, 2001). Moreover, quasi-experimental research in this area has been criticized for not adequately controlling for differences in instructional method (Clark, 1994) and learner characteristics (such as learner motivation and mental ability) that could explain differences in outcomes across conditions. Studies typically confound multiple variables and are thus unable to clearly attribute observed differences between training conditions to any one particular factor.

One quasi-experimental study that avoided confounds of different instructors, content, and methods was Sugrue, Rietz, and Hansen (1999). The authors examined learner performance in the same graduate level finance course, delivered by the same instructor, using the same materials, across traditional classroom and videoconferencing delivery methods. The authors also controlled for relevant individual difference characteristics, including general mental ability (GMA). They found that learners with poor pre-training attitudes did better on exams in classes where the instructor was always physically present compared to videoconferencing from a remote location. Theoretically, the physical presence of the instructor created a more motivating situation than videoconferencing, so learners were more likely to pay attention, less likely to be distracted, and thus more likely to learn. In communications research, instructor behaviors that motivate learners have been referred to as *immediacy* behaviors (Andersen, 1979).

Unfortunately, the Sugrue et al. (1999) study does suffer from a confounding variable. Sugrue et al. (1999) compared small and large videoconferenced course delivery to small face-to-face delivery, but they did not have data from a large, face-to-face class. Because average class size was not equivalent across the videoconferenced and non-videoconferenced versions of the course, the research design was unbalanced and videoconferencing effects may have been confounded with class size effects. Theoretically, class size can influence outcomes in ways similar to videoconferencing; larger classes may decrease student motivation and thus the likelihood that learners pay attention and learn (e.g., Glass & Smith, 1979; Hedges & Stock, 1983). Thus, it would be useful to extend the Sugrue et al. (1999) study with a balanced design that examines small and large classes with videoconferencing delivery and without.

The purpose of our study is to examine differences in training outcomes across classroom and videoconferencing classes for learners in classes of various sizes. Videoconferenced classes

are defined here by their use of 2-way video and audio to connect more than one classroom location during instruction. We report a balanced quasi-experimental design that crosses videoconferencing (with the instructor present every other class period) versus no videoconferencing (traditional classroom training) and class size (small versus large) in classes with the same instructor and materials. This study uses data from Sugrue et al. (1999) but adds another year of data to balance the design factors. We also extend the Sugrue et al. (1999) study by exploring the effect of validated individual characteristics on outcomes, examining both main effects and interactions. Finally, one individual characteristic, motivation to learn, is predicted to interact with videoconferencing and class size in determining training outcomes. Based on the theory of instructor immediacy, we expect that learners with low levels of motivation will be adversely affected by videoconferenced and larger classes, while learners with high levels of motivation will experience more positive outcomes in these instructional environments.

Literature Review and Hypothesis Development

Matchmes and Asher (2000) meta-analytically summarized prior research on adults learning from videoconferencing. Their results suggest small positive achievement gains for videoconferencing versus on-site instruction. Unfortunately, few studies examined adult learning with videoconferencing and most of these were quasi-experimental. As a result, selection effects may explain the observed results. That is, it is possible that learners with greater levels of general mental ability (Ree & Earles, 1991) and/or motivation to learn (Noe, 1986) pre-select into videoconferencing conditions. For example, Whetzel, Felker, and Williams (1996) found that pre-test scores were higher for learners taking the satellite delivered video course than the instructor-led courses. Although pre-tests were controlled for in the analysis, and the authors found that satellite learners experienced significantly greater gains in knowledge

across 2 different courses, it is possible that other differences between the learners were at play. Pre-test knowledge may have been only one of the differences between learners across conditions. Learners in the video condition may also have had greater general mental ability (GMA) and motivation to learn, which could explain the differential gain. Research that controls for these factors is clearly needed.

More theory driven research in this area would be helpful. Most studies simply compared one method of delivery with another to determine which is most effective. It would be more useful to have research that uses theory to explain delivery technology characteristics, and examines how these characteristics interact with learner characteristics. Moore and Kearsley (1996) note: "The more valuable questions to research are those concerning the characteristics of students within a group. We would like to know what types of students learn best in one environment, or from one medium, and what characterizes those who learn better from the alternatives" (p. 65). This study addresses the question of relative effectiveness of videoconferenced training, and examines its relative effectiveness for different types of learners.

Videoconferencing and Class Size as Situation Effects

General models of training effectiveness emphasize that the learning situation influences training outcomes (Baldwin & Ford, 1988; Mathieu & Martineau, 1997; Mathieu et al., 1992). Situation factors of interest in prior training research include instructional methods (e.g., Baldwin, 1992) and the behavior of the instructor (e.g., Towler & Dipboye, 2001). As the focus of this study is learning and not performance, instructor effects on learning are the primary focus.

From our perspective, we suggest that a key theoretical difference between videoconferenced and classroom instruction is the ability of the instructor to engage in communication that increases learner motivation and, thus, learning. This concept has been

studied in great detail over the past 20 years in communications research and has been labeled *instructor immediacy*.

Instructor immediacy is grounded in Mehrabian's (1981) notion of nonverbal communication that influences an audience's approach/avoid reaction to messages, immediacy has since been refined to capture the effect of instructors' verbal and nonverbal behaviors on student reactions, behavior, and learning outcomes. Research in this area argues that instructor behaviors such as making eye contact and standing close to students is pleasant to them, and boosts their motivation (Christophel, 1990; Richmond, Gorham, & McCroskey, 1987).

Research on immediacy has clearly demonstrated that learners rate the instructor and the class lower when immediacy behaviors are low (Christophel, 1990; Hess, Smythe, & Communication 451, 2001). In addition, there is some evidence that learners learn more when immediacy is high. However, this latter point is more controversial, as some authors have presented evidence that immediacy is not critical for learning (Chesebro, 2003; Hess et al., 2001). Examinations of instructor immediacy effects do not typically control for other differences in instructor characteristics and behavior, or for course content and method, all of which might influence learner motivation. Further tests of this hypothesis are warranted, particularly in environments where the instructor and content are held constant.

A strong test of instructor immediacy would involve examining the same instructor, teaching the same material with high and low immediacy styles. One such study was conducted by Witt and Wheeless (2001), who randomly assigned students to receive a short instructional video segment that was high or low in verbal and nonverbal instructional immediacy. They found strong effects for nonverbal immediacy on learner reactions and weak effects on recall of key points from the instruction. Verbal immediacy did not have these effects. However, the

instruction for this experiment was delivered by video, and lasted only 15-minutes. It is questionable whether immediacy can be fully manipulated in a video, as nonverbal immediacy behaviors on a videotape can never include direct eye contact and physical proximity. It is also questionable whether motivational effects occur in training programs that last for such a short period of time.

Our hypotheses arise from considering how videoconferencing training should affect learning outcomes through its effect on immediacy. Videoconferencing presents a practical barrier to immediacy behaviors because it: (1) constrains the instructor to work within a limited portion of the classroom (visible by the camera), (2) diminishes the instructor's ability to meet learners face-to-face, and (3) limits the amount of direct eye contact that can occur. In fact, prior research specifically demonstrates that learners rate video-provided instruction as less immediate than live instruction (Carrell & Menzel, 2001).

Webster and Hackley (1997) provided an illuminating description of videoconferenced classes that further supports the contention that this type of delivery creates low immediacy, even when the learner is in the same room with the instructor who is using the technology[1]. The authors quote a student in such a classroom as saying there is "less eye contact by the professor with the audience as he is busy concentrating on the monitor and the lecture notes and screening the off-site classroom" (p. 1297). A focus group discussing instructor contact in these classes also reported, "Instructor contact with students is not as direct and requires instructors to watch and look at various media…" (p. 1297). Finally, an observer who watched such a course noted,

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[1] Videoconferencing is often used to connect two or more locations, one of which is local (with the instructor present) and the other(s) remote. This was the case in the Webster and Hackley (1997) study and is the case with our study. Even though some students are in the same location as the instructor, we still refer to this as videoconferenced training for all learners because the instructor's immediacy behaviors are constrained by the use of the technology.

"The environment is stiff, sterile, and impersonal" and "it's like he is behind a barrier; the equipment separates him from the class" (p. 1297). Note that these particular effects would be observable for learners in the live classroom as well as the remote classroom. Thus, using videoconferencing as a delivery mechanism should constrain an instructor to less immediate behaviors, with the ensuing effects on reactions and learning. Therefore, based on the theory of immediacy, we propose the following hypothesis:

H1: Learning (and reactions) will be lower (less positive) in classes that use videoconferencing than in classes that do not use videoconferencing.

It is interesting to note that none of the classes observed by Webster and Hackley had more than 36 students, and the average class size was 16. Prior research demonstrates that people feel even more disconnected in videoconferencing when the number of people involved goes up (Gowan & Downs, 1994). Considerable research on early childhood education suggests benefits for small classes (Cooper, 1989 although see Slavin, 1989), but little research has been conducted on class size with adult learners.

Large classes, which for purposes of this study are defined as classes with more than 50 students, are similar to videoconferencing in the obstacles they present to instructor immediacy behaviors. As class size goes up, it is more difficult for the instructor to have contact and develop a sense of closeness with the learners. In other words, it is difficult for instructors to use immediacy behaviors throughout the entire class, making personal connections (eye contact, for example) that will motivate students to pay attention and learn. Therefore, we propose:

H2: Learning (and reactions) will be lower (less positive) in large classes compared to small classes.

Motivation to Learn and Person x Situation Effects

Videoconferencing and class size each capture situation effects on learning. Prior theory and research suggests that personal factors also play an important role in training outcomes. In particular, motivation to learn can vary considerably across learners before a training program even begins (Noe, 1986), and predicts learning outcomes across a number of studies (Colquitt et al., 2001). Motivation to learn refers to the desire by trainees to learn the material presented (Hicks & Klimoski, 1987; Noe, 1986).

While most research on motivation to learn focuses on main effects, learner characteristics may interact with situational factors to determine learning (Snow, 1994). Some learners may be sufficiently motivated that situational variables will have little influence on their learning outcomes. Motivated learners should be more willing to overcome obstacles presented by difficult or frustrating learning environments. From this perspective, an aptitude by treatment interaction (Snow, 1994) seems possible in the domains of videoconferencing and class size. More specifically, it is plausible that some trainees do not need instructor immediacy to build and sustain their motivation; the class material itself is sufficiently motivating. Moreover, highly motivated learners who desire or need interaction with the instructor may be sufficiently motivated to overcome obstacles presented by less immediate environments or seek out instructor contact on their own time. In contrast, learners with low levels of motivation may require instructor immediacy to engage them with the materials; the absence of immediacy may be very detrimental to their learning because the instructional environment is not providing them with the motivational boost they need to pay attention and learn.

Sugrue et al. (1999) offered some evidence for an interaction between motivation and videoconferencing. Controlling for learner GMA, they found that learners with initially poor

pre-training attitudes did best when the instructor was physically present each week; for learners with more positive pre-training attitudes, location of instructor did not matter. Sugrue et al. (1999), as noted before, did not have a balanced design, so the effects of videoconferencing could not be disentangled from the effects of class size.

We propose that high levels of motivation to learn render the effects of technology and class size, and associated immediacy behaviors, less critical for training outcomes. For learners with high levels of motivation to learn, differences in immediacy caused by different instructional conditions would have little or no effect. In contrast, for learners with low levels of motivation to learn, instructor immediacy would be important for building and sustaining motivation, and thus videoconferencing and large classes would be more detrimental to them. Therefore, we propose:

H3: Learners with low levels of motivation to learn will be more affected by videoconferencing and class size than learners with high levels of motivation.

Method

Participants

The study was conducted with students in an off-campus Masters in Business Administration (MBA) program at a large mid-western university using the core finance course (Managerial Finance). Courses were offered in the evening as nearly all students worked full-time. Participation in the study was voluntary. However, 207 out of 212 (98%) students who completed the class over a two-year period participated. Participants were on average 32 years old, and were 63% male and 92% white.

Study Design

Data for this study was collected over two academic years. The study used a quasi-experimental design with two design factors. The first was the delivery technology. Each year, two sites were taught simultaneously using a fiber-optic communications network, which permitted two-way, full motion audio/video broadcasts. The instructor alternated between the two sites every other week. The third site each year did not use videoconferencing. Instead the instructor was present at the site for all class meetings. Thus, in total, there were four videoconferenced classes and two stand-alone classes. The second design factor was class size. Four of the classes were relatively small, with final enrollments ranging from 20 to 36 students. Two of the classes were relatively large, with final enrollments of 57 and 64 students. As compared to prior research on class size, the small classes in our study are relatively large (average size of 30 students versus fewer than 20 for small classes as discussed by Slavin, 1989). Consequently, effects of class size in this study may not be as large as the effects in prior research (e.g., Glass & Smith, 1979). Specific characteristics of each class, and their descriptive statistics, are displayed in Table 1.

-- INSERT TABLE 1 ABOUT HERE --

Instructional Materials

The course consisted of: (1) interactive lectures (definitions of terms and worked examples) during which students were encouraged to ask questions; (2) cases that students worked on in groups outside of class and presented solutions in class; (3) assignments that students worked on in groups outside of class; (4) two examinations taken in class; (5) access to course materials and assignments on a web site, (6) access to the instructor and teaching assistants via email and on-site office hours.

The instructor developed the materials over a two year period prior to this study while teaching the course in both traditional and videoconferenced classes. During the development period, the lecture materials, cases, and assignments were designed and refined to fit a variety of learning environments. Upon the start of data collection, all instructional materials were finalized and fixed; the only changes between classes and years were corrections of minor typographical errors. Moreover, because the same experienced instructor was used across all conditions, instructor characteristics and behaviors unrelated to videoconferencing and class size are held essentially constant. Thus, we isolate as much as practically possible the delivery technology from other possible instructional confounds.

Study Procedure

To control for instructor effects other than those presented by videoconferencing and class size, the same instructor taught all the courses. On the first day of each class in the study, students were given a brief survey that included measures of prior experience, prior knowledge, and motivation to learn. In addition, students were asked to provide permission for the researchers to access their GMAT score from their student records. Midterm and final exams were problem-based and were offered halfway through the course and at the end of the course, respectively. Reactions to the course were collected as part of the regular course/instructor evaluation procedure used by the university. At the last class meeting, students answered questions about their perceptions of and satisfaction with the course and instructor. By policy, these forms are completed anonymously, so the reaction data cannot be matched to exam grades.

Measures

GMA. Students' GMAT scores were obtained from university records and used as a measure of GMA. Standardized test scores are good indicators of GMA, have high levels of

reliability (.92 for GMAT, http://www.gmac.org/gmac/thegmat), and have been found to have powerful effects on learning (Ree & Earles, 1991).

Prior Knowledge. As a measure of incoming domain knowledge, students completed a 12-item pretest. Items ranged in difficulty, with one item answered correctly by only 1% of students and another item answered correctly by 92% of students. The average number of correct responses for participants was 4 (33% correct) with a standard deviation of 1.70. The KR-20 reliability is .47. This reliability is relatively low by psychometric standards in part because it is a short instrument attempting to capture a broad area of knowledge.

Prior Experience. The initial survey asked students to rate their personal experience with finance. Specifically, the survey asked students to indicate, "How much experience have you had using and applying financial concepts and principles?" Response options included: Novice (have not used or applied financial concepts); Limited (have used financial concepts on a few occasions); Experienced Amateur (often used financial concepts, but am not employed in a finance field); and Professional (paid for applying concepts in a finance field, e.g., corporate finance, investments, banking, real estate, insurance, etc.).

Motivation to Learn. Students completed a 2-item motivation to learn survey at the start of training including both enthusiasm ("How enthusiastic are you about taking this course?") and perceived value of the course ("How valuable do you think this course will be to you?"). Students rated their response on a 5-point Likert scale with strongly agree to strongly disagree anchors. Answers to these items were correlated ($r = .34$, Cronbach's $\alpha = .50$). Although this reliability is relatively low, the two-item composite (rather than either single item, or both items separately) was used because we believe it more fully captures motivation to learn as defined in the literature (e.g., Noe, 1986). The low reliability of this measure reduces the power to detect a

main effect for motivation as well as the hypothesized interactions.

Reactions. To assess learner reactions, anonymous evaluations submitted by students were used. Between the two years of this study, the university changed the forms used for these evaluations. Across these forms, ten questions remained essentially identical, but the rating scales changed from 5-point to 6-point scales. Given differences in wording and scale points, no attempt was made to use factor analysis and create common scales across years. Instead, items were examined independently. To control for the difference across years, responses were standardized within year.

Learning. Scores on midterm and final examinations were used to assess learning. Midterm and final scores were highly correlated ($r = .66$, Cronbach's $\alpha = .80$). To capture learning that occurred throughout the semester, scores on the tests were summed. Exams were common across classes in a year and were similar, but did differ slightly, across years. To control for minor differences in the exams, scores were standardized within year.

Results

Table 1 summarizes the incoming characteristics and learning scores of the students overall and in each class. To determine if there were differences in GMA, prior experience, prior knowledge, and motivation to learn across the six classes, a multivariate analysis of variance was conducted with classes as the independent variables. Results are significant at the .10 probability level, Pillai's Trace $F(20, 735) = 1.43$, $p = 0.10$, suggesting some differences in these variables were found across classes. Post hoc one-way analyses of variance results suggest small differences between two classes on two variables. Students in the year 1, site 1 class (large, videoconferenced) had lower average prior financial experience ($p < .05$) and knowledge ($p < .05$) than students in the year 2, site 1 (large, classroom) class. With only two differences among

all pairwise comparisons of 6 classes along 4 variables, the students appear to be drawn from very similar populations. Nevertheless, prior experience and knowledge are controlled in all subsequent analyses.

-- INSERT TABLE 2 ABOUT HERE --

Table 2 provides correlations among study variables. Reactions are not included in this table because reaction data were collected anonymously and could not be paired with the individual-level data in this table (e.g., GMA, prior knowledge, etc.). Supporting the use of GMA, prior knowledge, and prior experience as controls, all of these variables were correlated with learning score. Both videoconferencing and class size have negative correlations with learning, but the zero-order coefficients are small and not significant ($p > .05$).

Learning

H1 proposed that videoconferencing would have a negative effect on learning and reactions, and H2 proposed that large class size would have a negative effect as well. Table 3 presents the hierarchical regression analyses for learning (results for reactions will be presented later). In Table 3, the regression used to test H1 and H2 are presented in Step 1. Step 2 adds the interaction terms to test H3. One assumption of regression is that the predictors are not highly correlated; Table 2 clearly indicates that the primary variables of interest (motivation to learn, class size and videoconferencing) are essentially uncorrelated.

-- INSERT TABLE 3 ABOUT HERE --

Step 1 of the regression shows that the effect of videoconferencing on performance was negative and significant at the .10 probability level ($B = -.24$, $p = .06$). This suggests H1 is supported with regard to learning. Step 1 also shows that, consistent with the learning hypothesis of H2, the effect of class size was negative and significant ($B = -.38$, $p < .05$). Post

hoc analysis of performance revealed that the *best* learning environment for the average student was the small, non-videoconferenced class (where the average student is predicted to score 0.32 standard deviations above the overall average). The *worst* environment was the large, videoconferenced class (where the average student is predicted to score 0.29 standard deviations below the overall average). Thus, both H1 and H2 received support with regard to learning.

H3 predicted that the effects of videoconferencing and class size would be diminished by higher levels of learner motivation. This hypothesis can only be tested for learning, as the individual-level motivation data could not be matched with individual-level reactions. Step 2 in Table 3 examines this hypothesis by adding the 2-way interactions between motivation to learn and the situation variables, and between the situation variables. Results show a large effect for the two-way interaction between videoconferencing and motivation ($B = .84$, $p < .05$) and an effect significant at the .10 probability level for the classroom size and motivation interaction ($B = .51$, $p = .06$). Both interactions have the same form – learners with low motivation learn more than learners with high motivation in high immediacy contexts (small classes, non-videoconferenced classes), and learners with low motivation learn less than learners with high motivation in low immediacy contexts (large classes, videoconferenced classes). Moreover, learners with low motivation performed differently across the different types of classes, but learners with high motivation performed nearly the same across the different types of classes. In other words, learners with low levels of motivation were more affected by the classroom situation than students with high levels of motivation. These results support H3. Unreported regressions show that none of the 3-way interactions and none of the other interactions between classroom situation (class size, videoconferencing) and other personal characteristics (GMA, prior knowledge, or prior experience) were significant.

To depict the class size x motivation interaction effect, the regression equation in Table 3 was used to plot predicted differences in learning across motivation levels and class size (see Figure 1). An otherwise average student with low motivation (-1 SD) is predicted to learn considerably more in small classes (.33 predicted standardized score) than in large (-.23 predicted standardized score). The difference in learning is substantial (.56 standard deviation difference), particularly compared to the difference for an otherwise average student with high motivation (+1 SD), where the difference is .07 standard deviation units between the small to large class.

-- INSERT FIGURE 1 ABOUT HERE --

To depict the videoconferencing/motivation interaction effect, predicted differences in learning across motivation levels and videoconferencing were plotted (see Figure 2). An otherwise average student with low motivation (-1 SD) is predicted to learn more in non-videoconferenced classes (.37 predicted standardized score) than in videoconferenced classes (-.22). In contrast, students with high motivation (+1 SD) are predicted to learn slightly more in videoconferenced classes (.02) than non-videoconferenced classes (-.13). The difference in learning across the videoconferenced and non-videoconferenced courses is considerably smaller for high motivation students (.15 standard deviation units) than for low motivation students (.59 standard deviation units), consistent with H3.

-- INSERT FIGURE 2 ABOUT HERE --

Table 4 presents statistical comparisons for the predicted scores [2]. The table indicates that predicted scores do not vary across class size and across videoconferencing for high motivation students. For low motivation students, predicted scores were significantly different in both conditions. To examine the joint effect of large classes and videoconferenced classes, a joint effect comparison is also reported at the bottom of Table 4. This analysis compares predicted student learning from the small, non-videoconferenced course and the large, videoconferenced course. Predicted learning scores for high motivation students did not differ significantly across type of class (standardized difference = 0.14), but learning scores did differ significantly for low motivation students (standardized difference = -.1.15). Moreover, consistent with H3, the greatest overall difference in learning was between low motivation students across the highest (i.e., small, non-videoconferenced) and lowest (i.e., large, videoconferenced) immediacy situations.

-- INSERT TABLE 4 ABOUT HERE --

Reactions

H1 and H2 predicted that reactions, as well as learning, would be affected by training characteristics. Table 5 presents the reaction items used. In Table 6, the regression analyses are presented. Because the reaction data used here was taken using university-sponsored ratings, the data was anonymous and could not be associated with other learner characteristics. For each item, scores were standardized by subtracting the mean for that year from the item score and

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[2] An alternative way to show the significance of the interactions is to run separate regressions for small and large classes, and for videoconferenced and non-videoconferenced classes, and examine the differences in regression coefficients for motivation to learn. The results using this approach are similar to those reported above. Between large and small classes, the difference in the unstandardized coefficients on motivation to learn was 0.46 ($t = 1.64$, $p = .10$). Between videoconferenced and non-videoconferenced classes, the difference in the unstandardized coefficients on motivation to learn was 0.91 ($t = 3.16$, $p < .01$). Motivation to learn was a more powerful predictor of learning in the large and in the videoconferenced courses, as H3 would suggest.

dividing by the standard deviation for that year. As a control variable, standardized GPAs were calculated for each year by taking the grade points assigned to each student minus that year's average divided by that year's standard deviation. The average standardized GPA for each class was added as a control variable.

-- INSERT TABLES 5 and 6 ABOUT HERE --

With regard to H1 (videoconferencing effects), 5 of the 9 reaction items were significantly lower (more negative) for videoconferenced than non-videoconferenced courses (learning, organization, exams, preparation, recommendation). Thus, H1 was supported with regard to reactions. In contrast, class size had no significant effect on any of the reaction measures. Thus, H2 (class size effect) was not supported with regard to reactions.

Instructor Observations

The second author served as the instructor for all of these classes. His experience teaching these classes is consistent with the hypotheses (learning and reactions are worse in large and videoconferenced classes) and with the instructor immediacy construct as an explanation. In videoconferenced courses immediacy behavior was inhibited in two ways. First, there were the obvious challenges associated with interacting with students via technology. It was more difficult to connect with students via a video-link and encourage their participation. It was also harder for the instructor to get feedback (both verbal and non-verbal) from the remote students. These problems were exaggerated in the large class where there were larger numbers of remote students. The on-site coordinator reported on several occasions that remote students' attention appeared to wander, and some simply left the classroom. Second, videoconferencing presented challenges in the local classroom because of the technology demands. Trying to stay in the camera range and, in fact, spend most of the time looking at the camera, inhibited interaction

with students at the local videoconferenced classroom. In addition, videoconferencing reduced direct eye contact and direct student/instructor interaction in the local classroom because of the need to "look into the camera." In fact, the local students seldom watched the instructor directly. They usually watched his camera image displayed on the screen next to him, creating an odd Oz-like interaction.

Discussion

The purpose of this quasi-experimental study was to examine the effects of videoconferencing and class size on training outcomes. Specifically, using the theory of instructor immediacy, we hypothesized that training outcomes would be worse for large and for videoconferenced classes. Moreover, the immediacy theory posits that instructor behaviors serve to motivate learners, so the low immediacy environments should be most problematic for learners who begin the course with low levels of motivation. Viewed from another angle, we believed that the effects of immediacy provided by small, face-to-face classes would be unnecessary for motivated learners. Thus, this study provides a multivariate examination of person and situation factors that affect learning and reactions, conducted using a delivery medium that is being used with greater frequency in companies and universities. To avoid confounds from other instructional variables, the study was conducted with the same instructor teaching the same content and using the same instructional methods. In this way, this study contributes to literatures on videoconferencing and training motivation by providing a rigorous quasi-experiment on the effects of videoconferencing in large and small classes, and with high and low motivation students. More specifically, it refines and expands the findings of the Sugrue et al. (1999) study on videoconferencing.

Results with regard to learning support the hypotheses. Learners generally did worse in large and in videoconferenced classes. Moreover, the hypothesized interactions were found. The negative effects of videoconferenced and large classes were more pronounced for learners with low motivation. Students with low motivation benefited from small and from non-videoconferenced classes. Learners with high levels of motivation to learn did not perform differently across any of the instructional environments.

Results for reactions offered mixed support of the hypotheses. There were no differences in reactions between the large and small classes. Videoconferencing, however, did have a negative effect. Across the board there were less positive reactions to the videoconferenced version of the class. This is particularly noteworthy because the same instructor was teaching the same content using the same materials across the videoconferenced and non-videoconferenced versions. Nevertheless, students in the videoconferenced versions were less satisfied and less likely to recommend the instructor to other students. So using videoconferencing to deliver training may offer practical advantages, but it also presents obstacles with regard to learning and reactions. This point is elaborated below.

Practice Implications

This study has implication for the use of videoconferenced training in organizations. Most prominently, these results suggest that lower learning and less positive reactions may occur as a result of moving face-to-face training to videoconferenced delivery. Moreover, these negative effects will be most pronounced for those learners who are not motivated at the start of training. This suggests that organizations should determine the initial motivation levels of trainees as part of a needs assessment, and use the data to help select delivery media for training.

Learners with low levels of motivation should receive more direct interaction with the instructor as a means to prevent poor learning outcomes.

In many ways, this study provides a conservative test of the effects of videoconferencing in organizations. The actual use of videoconferencing in organizations is typically different in several ways from this study. First, in this study, all remote learners were in the same location and operated as an intact "class" even when the instructor was at a remote location. In web conferencing, learners are usually at multiple locations, which would further reduce immediacy, and increase distractions. Second, in this study there was two-way full-motion video communication. In web conferencing there is usually not full motion video; the instructor's image may be on the screen and learners hear live audio to go with slides. The absence of real-time video should further reduce the perception of immediacy. And, third, in this study, the learners using videoconferencing had the instructor on site for half of the classes. In web conferencing, the instruction is usually remote throughout the entire class. Thus, the effects for videoconferencing presented here may be conservative; negative effects in organizations may be even more severe.

What can be done to improve training outcomes when videoconferencing is used? We believe that instructor efforts to raise immediacy and boost motivation would be appropriate. Raising immediacy in videoconferenced classes would require deliberate efforts to interact with learners via the technology, asking and answering individualized questions. It might also involve using time outside of class to get to know learners personally. More broadly, theory and research suggests that instructors can boost motivation in a number of ways: (1) tell attention-grabbing stories, (2) promote relevance of training to learners, (3) promote confidence that the learners can learn the material, (4) provide choice in activities, (5) provide supportive and

encouraging feedback, and (6) offer opportunities for interaction (Keller & Suzuki, 1988; Sheldon, Turban, Brown, Barrick, & Judge, 2003). Regardless of the specific effort employed, instructors in videoconferenced training should be sensitive to the issue of trainees' motivation. More specifically, when instructors in videoconferenced training determine that motivation to learn is low, they should attempt to boost motivation or shift the training to face-to-face, if feasible.

Research Implications

This study provides partial support for the theory of instructional immediacy and suggests it may prove fruitful for developing hypotheses about media effects on learning. The results support the conclusion that learners who have low motivation experience a learning benefit from small and non-videoconferenced classes relative to large and videoconferenced classes. Continued research on instructional immediacy as an explanatory mechanism for situation effects seems warranted.

Another interesting finding worthy of future research was that motivation to learn did not have a strong bivariate relationship with learning ($r = .05$, $p > .10$), as prior research would have predicted (Colquitt et al., 2000). While this may result in part from the low reliability of the instrument, a purely psychometric explanation seems unlikely given that significant interactions were detected. Thus, a tentative conclusion relevant to future research is that pre-training motivation is not equally important in all learning situations. One reason this may be true is that motivation levels change as a result of the learning situation. Prior research on motivation to learn has generally assessed motivation prior to the start of training, as we have in this study. This approach presumes that motivation is stable, which may not be tenable, particularly in the context of a multi-session course. Instructor immediacy theory, for example, predicts that

instructors can raise learners' motivation by engaging in certain behaviors. Future research should directly examine changes in motivation over time. If motivation to learn changes, then measures collected later in a course, following the influence of the instructor's behaviors, may have more powerful effects on learning outcomes than measures collected before the course begins. Future research on this point is encouraged, and would benefit from the use of a more reliable measure of motivation to learn, which would reduce problems associated with measurement error.

We also encourage future research to examine interactions between motivation to learn and other instructional characteristics. Our results clearly support a person x situation perspective on motivation and instructional delivery. The Colquitt et al. (2000) meta-analysis indicated considerable variation in the correlations among motivation to learn, declarative knowledge, and skill acquisition across studies. Thus, future research on moderators of the relationship between motivation to learn and learning outcomes is warranted. Similarly, moderators of the relationship between instructional delivery characteristics and training outcomes should be explored. Some suggestions for research in this area includes continuing to examine personal characteristics of learners, instructor characteristics (e.g., Towler & Dipboye, 2001), and training cohort characteristics (Baldwin & Magjuka, 1997).

Future research on class size is also suggested. In this study, class size was operationalized with large classes having over 50 students and small classes having around 30 students. These numbers are somewhat arbitrary and were driven entirely by course demand in this study. Because prior research in K-12 settings has operationalized "small" classes as having fewer than 15 students, future research with smaller classes is needed. In organizations, training may be as small as one-on-one and as large as a large conference facility (well over 100

employees). Research using a wider range of class sizes may find larger effects for class size than we found in this study.

Limitations and Conclusion

Learners in this study were taking a required course in a graduate degree curriculum, so they are not representative of all workplace learners. With that said, the degree program in question draws current employees from multiple companies. So, with regard to employment status, experience, and age, this population is more representative of workplace learners than a sample of undergraduate students, and it is not limited to employees from a single company as a company-sponsored training program would be. Other study limitations include the lack of direct measures of immediacy and modest reliability of the motivation and learning constructs.

Because the design used was quasi-experimental, it is possible that differences in learners existed across classes. Few differences were found across the available variables (ability, prior knowledge, experience, and motivation), thus the possibility that selection effects explain these results are diminished. Another threat to internal validity in quasi-experimental designs is "resentful demoralization of those receiving less desirable treatment" (Cook & Campbell, 1979). Learners in this class may have been aware that there were sections of this course that were not delivered via videoconferencing, and/or were offered in smaller sections. This awareness may have led to frustration and a general sense of inequity, which may have reduced motivation and thus learning. Prior research suggests that fairness perceptions can influence motivation to learn (Quinones, 1995). Although this effect is possible, it seems unlikely given the circumstances. Individuals in this degree program are working adults who select courses largely based on schedule availability. They seldom interact with individuals outside of their immediate classes in

large part because the average distance between the three class locations was 106 miles. So they would be unlikely to have continued interaction with students in other sections of the course.

A more plausible alternative explanation is that the instructor treated members of each class differently for reasons unrelated to class size, videoconferencing, and instructor immediacy. For example, the instructor may have provided clearer explanations to a particular class because it contained more extraverted and agreeable students. A larger sample of each type of class, and direct observations of instructor immediacy and other instructional behaviors, would be useful to rule out this competing explanation.

Overall, these results provide support for the theory of instructional immediacy by demonstrating negative learning and reaction effects for videoconferencing, and negative learning effects for class size. The results for learning also support a person x situation interaction perspective. Learners with low motivation learned considerably less in large, videoconferenced courses than in other versions of the course. Consequently, any cost savings that an organization obtains from moving training from the classroom to large, videoconferenced courses should be weighed against the costs associated with lower levels of learning for some learners.

References

Andersen, J. F. (1979). Teacher immediacy as a predictor of teaching effectiveness. *Communication Yearbook, 3*, 543-559.

Baldwin, T. T. (1992). Effects of alternative modeling strategies on outcomes of interpersonal-skills training. *Journal of Applied Psychology, 77*, 147-154.

Baldwin, T. T. & Magjuka, R. J. (1997). Training as an organizational episode: Pretraining influences on trainee motivation. In K. Ford & Associates (Eds.), *Improving training effectiveness in work organizations* (pp. 99-127). Mahwah, NJ: Lawrence Erlbaum.

Carrell, L. J., & Menzel, K. E. (2001). Variations in learning, motivation, and perceived immediacy between live and distance education classrooms. *Communication Education, 50*, 230-240.

Chesebro, J. L. (2003). Effects of teacher clarity and nonverbal immediacy on student learning, receiver apprehension, and affect. *Communication Education, 52*, 135-147.

Christophel, D. (1990). The relationships among teacher immediacy behaviors, student motivation, and learning. *Communication Education, 39*, 323-340.

Clark, R. E. (1994). Media will never influence learning. *Educational Technology Research and Development, 42*, 21-29.

Colquitt, J. A., LePine, J. A., & Noe, R. A. (2000). Toward an integrative theory of training motivation: A meta-analytic path analysis of 20 years of research. *Journal of Applied Psychology, 85*, 678-707.

Cook, T. D. & Campbell, D. T. (1979). *Quasi-experimentation: Design and analysis in field settings*. Boston, MA: Houghton Mifflin.

Cooper, H. (1989). Does reducing student-to-instructor ratios affect achievement? *Educational Psychologist, 24*, 79-98.

Glass, G. V. & Smith, M. L. (1979). Meta-analysis of the research on class size and achievement. *Educational Evaluation and Policy Analysis, 1*, 2-16.

Gowan, J. A. & Downs, J. M. (1994). Video conferencing human-machine interface: A field study. *Information & Management, 27*, 341-356.

Hedges, L. V. & Stock, W. (1983). The effect of class size: An examination of rival hypotheses. *American Educational Research Journal, 20*, 63-85.

Hess, J. A., Smythe, M. J., & Communication 451. (2001). Is teacher immediacy actually related to student cognitive learning? *Communication Studies, 52*, 197-219.

Hicks, W. D. & Klimoski, R. (1987). The process of entering training programs and its effects on training programs. *Academy of Management Journal, 30*, 542-552.

Keller, J.M., & Suzuki, K. (1988). Use of the ARCS motivation model in courseware design. In D. H. Jonassen (ED.) *Instructional designs for microcomputer courseware*. Hillsdale, NJ: Lawrence Erlbaum.

Machtmes, K., & Asher, J. W. (2000). A meta-analysis of the effectiveness of telecourses in distance education. *American Journal of Distance Education, 14*, 27-46.

Mathieu, J. E. & Martineau, J. W. (1997). Individual and situational influences on training motivation. In J. K. Ford & Associates (Eds.), *Improving training effectiveness in work organizations* (pp. 193-222). Mahwah, NJ: Erlbaum.

Mathieu, J. E., Tannenbaum, S. I., & Salas, E. (1992). Influences of individual and situational characteristics on measures of training effectiveness. *Academy of Management Journal, 35*, 828-847.

Mehrabian, A. (1981). *Silent messages* (2nd ed.). Belmont, CA: Wadsworth.

Moore, M. G. & Kearsley, G. (1996). *Distance education: A systems view*. Belmont, CA: Wadsworth.

Noe, R. A. (1986). Trainee's attributes and attitudes: Neglected influences on training effectiveness. *Academy of Management Review, 11*, 736-749.

Quinones, M. A. (1995). Pretraining context effects: Training assignment as feedback. *Journal of Applied Psychology, 80*, 226-238.

Ree, M. J. & Earles, J. A. (1991). Predicting training success: Not much more than g. *Personnel Psychology, 44*, 321-332.

Richmond, V. P., Gorham, J. S., & McCroskey, J. C. (1987). The relationship between selected immediacy behaviors and cognitive learning. *Communication Yearbook, 10*, 574-590.

Sheldon, K., Turban, D., Brown, K. G., Barrick, M., & Judge, T. A. (2003). Applying Self-Determination Theory to organizational research. In J. Martocchio (Ed.), *Research in Personnel and Human Resource Management, 22*, 357-431. New York: Elsevier Science.

Slavin, R. (1989). Class size and student achievement: Small effects of small classes. *Educational Psychologist, 24*, 99-110.

Snow, R. E. (1994). Abilities in academic tasks. In R.J. Sternberg & R.K. Wagner (Eds.), *Mind in context: Interactionist perspectives on human intelligence*. New York: Cambridge University Press.

Sugrue, B. (2003). *State of the industry: ASTD's annual review of U.S. and international trends in workplace learning and performance*. Alexandria, VA: ASTD.

Sugrue, B., Rietz, T., & Hansen, S. (1999). Distance learning: Relationships among class size, instructor location, student perceptions, and performance. *Performance Improvement Quarterly, 12*, 43-56.

Towler, A. J & Dipboye, R. L. (2001). Effects of trainer expressiveness, organization, and trainee goal orientation on training outcomes. *Journal of Applied Psychology, 86*, 664-673.

Webster, J. & Hackley, P. (1997). Teaching effectiveness in technology-mediated distance learning. *Academy of Management Journal, 40*, 1282-1309.

Whetzel, D. L., Felker, D. B., & Williams, K. M. (1996). A real world comparison of the effectiveness of satellite training and classroom training. *Educational Technology Research and Development, 44,* 5-18.

Witt, P. L., & Wheeless, L. R. (2001). An experimental study of teacher's verbal and nonverbal immediacy and student's affective and cognitive learning. *Communication Education, 50,* 327-342.

Table 1. Means and Standard Deviations of Study Variables Across Classes

Site	Statistic	Cognitive Ability	Prior Knowledge	Prior Experience	Motivation to Learn	Learning
Year 1, Site 1 Large Video	n	55	63	62	61	60
	M	564.00	3.82	1.90	2.94	-0.23
	SD	72.00	1.72	0.97	0.55	1.01
Year 1, Site 2 Small Video	n	19	22	22	22	22
	M	561.05	4.64	2.23	3.05	0.45
	SD	92.31	1.81	1.07	0.41	0.87
Year 1, Site 3 Small Classroom	n	25	30	30	30	29
	M	544.40	3.53	1.93	2.97	0.14
	SD	82.16	1.70	0.94	0.47	0.95
Year 2, Site 1 Large Classroom	n	57	53	53	54	57
	M	544.04	4.15	2.55	3.09	0.05
	SD	77.27	1.42	0.97	0.44	0.89
Year 2, Site 2 Small Video	n	17	21	21	21	20
	M	538.24	4.43	2.43	3.05	0.09
	SD	125.56	1.86	1.12	0.47	0.97
Year 2, Site 3 Small Video	n	24	24	24	24	24
	M	535.83	3.46	1.92	3.06	-0.19
	SD	84.54	1.61	0.72	0.47	1.27
Overall	N	197	213	212	212	212
	M	549.80	3.97	2.16	3.02	.00
	SD	83.59	1.68	1.00	0.48	1.00

Table 2. Correlations among Study Variables (N = 184)

Variable	1	2	3	4	5	6	7
1. GMA	(.92)						
2. Prior Knowledge	.19*	(.47)					
3. Prior Experience	.00	.36*	--				
4. Motivation to Learn	-.07	.16*	.26*	(.50)			
5. Videoconferencing	.06	.02	-.14*	-.05	--		
6. Class Size	.06	.00	.05	-.01	-.16*	--	
7. Learning	.50*	.31*	.15*	.05	-.06	-.11	(.80)

* $p < .05$, two-tailed.

Note. GMA = general mental ability; Videoconferencing = videoconferenced (0) or non-videoconferenced (1); Class Size = small (0) or large (1) class. Reliability estimates, where available, are presented in the diagonal.

Table 3. Regression of Learning Score on Learner and Class Characteristics (N = 184)

Variable	B	SE B	Adj. R^2	ΔR^2
Step 1			0.30*	--
Constant	-3.45*	0.60		
GMA	0.01	0.00		
Prior Knowledge	0.10	0.00		
Prior Experience	0.05	0.07		
Motivation to Learn	0.04	0.14		
Videoconferencing	-.24+	0.13		
Class Size	-.38*	0.13		
Step 2			0.34*	0.04*
Video x Class Size	-0.04	0.27		
Video x Motivation	0.84*	0.28		
Class Size x Motivation	0.51+	0.27		

* $p < .05$, two-tailed. + $p < .10$, two-tailed.

Table 4. Predicted Learning Score By Class Characteristics

Videoconferencing (at Average Class Size)		
	High Motivation Students (+1 SD)	**Low Motivation Students (-1 SD)**
Non-Videoconferenced	-0.13	0.37
Videoconferenced	0.08	-0.22
Difference	0.21	-0.59*
SE of Difference	0.19	0.18

Class Size (at Average Videoconference Use)		
	High Motivation Students(+1 SD)	**Low Motivation Students(-1 SD)**
Small Classes	0.04	0.33
Large Classes	-0.03	-0.23
Difference	-0.07	-0.56*
SE of Difference	0.19	0.17

Joint Effect (Small, Non-Videoconferenced vs. Large, Videoconferenced)		
	High Motivation Students(+1 SD)	**Low Motivation Students(-1 SD)**
Small, Non-Videoconferenced	-0.10	0.67
Large, Videoconferenced	0.04	-0.48
Difference	0.14	-1.15*
SE of Difference	0.31	0.26

* $p < .05$, two-tailed.

Table 5. Reaction Items Across Years

Item Number	Short Name	First Year Reaction Items 5 point scale	Second Year Reaction Items 6 point scale
1	Learning	Concepts were presented in a manner that aided my learning	Concepts are presented in a manner that helps me learn
2	Concern	The instructor seems to be concerned with whether I learned the material	The instructor seems concerned with whether I learn the course content
3	Interest	The instructor seemed interested in teaching this course	The instructor seemed interested in teaching this course
4	Questions	My questions were answered fully and completely	Questions are answered clearly and concisely
5	Availability	Instructor was available to me outside of class	Help is available outside class if I have questions
6	Organization	Class presentations seemed well organized	This course is well planned and organized
7	Exams	Exams allowed me to adequately demonstrate what I learned	Exams allow me to adequately demonstrate what I have learned
8	Preparation	The instructor appeared to be prepared for class	This instructor is prepared for each class
9	Recommendation	I would recommended this instructor to others	I would recommend a course taught by this instructor to other students

Table 6. Regression Analyses of Reaction Items on Class Characteristics

	Reaction Items								
Variable	**1 Learning**	**2 Concern**	**3 Interest**	**4 Questions**	**5 Avail-ability**	**6 Organi-zation**	**7 Exams**	**8 Prepara-tion**	**9 Recom-mend**
Constant	0.24	-0.04	0.12	-0.04	0.12	0.21	0.30	0.21	0.18
	(0.17)	(0.17)	(0.19)	(0.20)	(0.23)	(0.18)	(0.16)	(0.18)	(0.19)
GPA	0.73	0.89*	0.79	1.03*	0.54	0.44	0.67	0.35	0.66
	(0.45)	(0.40)	(0.62)	(0.45)	(0.59)	(0.44)	(0.43)	(0.47)	(0.41)
Video-conferenced	-0.50*	-0.18	-0.42	-0.13	-0.46	-0.51*	-0.52*	-0.56*	-0.48*
	(0.20)	(0.19)	(0.22)	(0.21)	(0.25)	(0.21)	(0.20)	(0.23)	(0.22)
Class Size	0.02	0.26	0.10	0.24	0.11	0.10	-0.15	0.12	0.12
	(0.20)	(0.21)	(0.19)	(0.23)	(0.24)	(0.20)	(0.20)	(0.18)	(0.21)
Video x Size	0.18	0.05	0.29	-0.03	0.34	0.15	0.33	0.24	0.14
	(0.29)	(0.29)	(0.29)	(0.31)	(0.32)	(0.29)	(0.28)	(0.28)	(0.29)
N	196	196	196	194	190	196	196	196	196
Adj. R^2	0.08*	0.04*	0.06*	0.05*	0.05*	0.06*	0.06*	0.07*	0.07*

* $p < .05$, two-tailed.

Note. GPA = average class grade-point average. Unstandardized coefficients are presented first, followed by standard errors in parentheses.

Figure 1. Effects of Class Size and Motivation on Learning

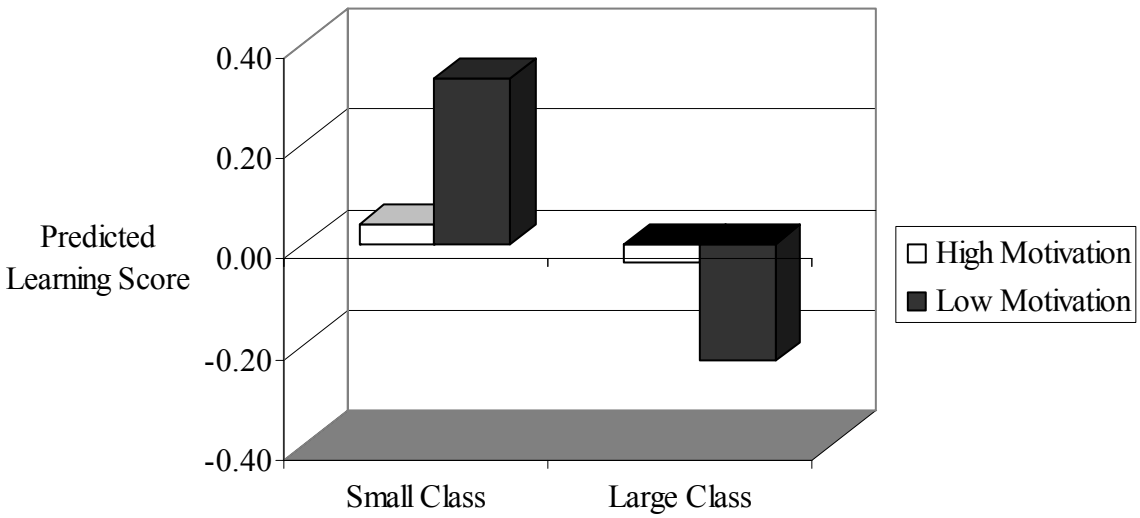
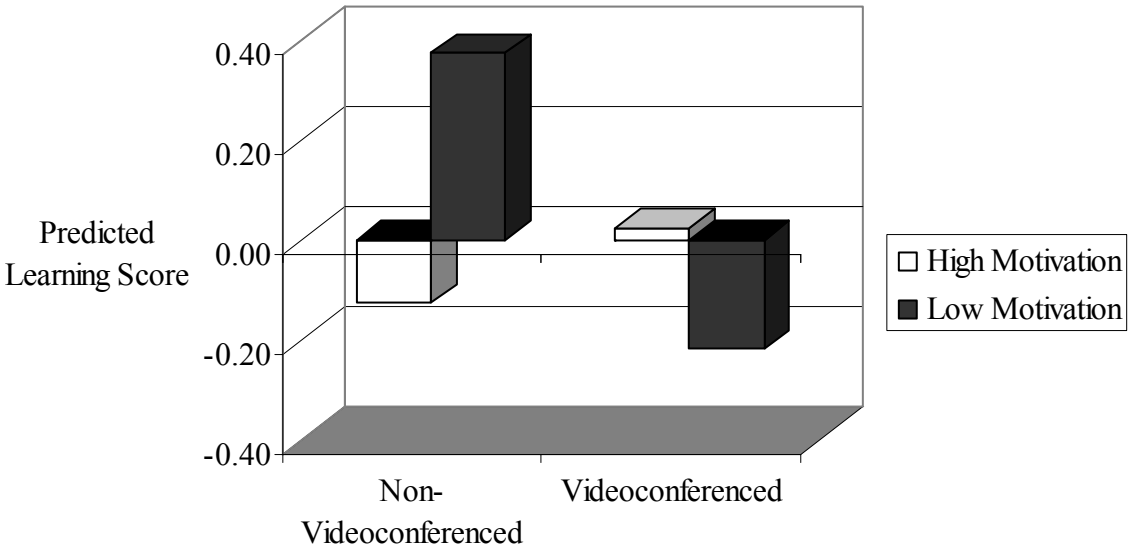


Figure 2. Effects of Videoconferencing and Motivation on Learning



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