

The Efficacies of Utilizing a Multimedia Based Instructional Supplement on Learners' Cognitive Skills

Peter M. Theuri

Northern Kentucky University

Bertie M. Greer

Northern Kentucky University

Leslie D. Turner

Palm Beach Atlantic University

Abstract

Calls for creative and more interesting ways of teaching and learning continue to echo in academia. In this study, we conduct an experiment to determine whether a multimedia based instructional supplement (MBIS), prepared using business and accounting students as presenters enhances any or all four lower-level Bloom's taxonomy cognitive skills of *remembering*, *understanding*, *applying*, and *analyzing*. We offer further and unique insight towards the understanding of technology's impact on learning since this study identifies the specific students' cognitive skills impacted by the use of technology for learning. Using the posttest control group design, students were randomly assigned to either the experimental or control group. We perform univariate as well as a multivariate analysis of covariance test (MANCOVA) to test for differences between the groups. Results indicate that such a MBIS is beneficial not only for enhancing students' overall performance, but more specifically in enhancing *understanding*, *applying*, and *analyzing* levels of cognitive skills.

Background

Faculty are continuously being challenged to find new and innovative ways to deliver and improve business instruction. In the midst of constantly changing technology, calls for increased use of technology in the classroom continue to echo in academia (AECC, 1990; Bryant et al. 2000). In fact, Bryant and Hunton (2000) challenge faculty to engage in accounting education research in the area of educational technology in an effort to discover and encourage more effective and efficient course delivery alternatives. More specifically, they point to studies that consider the interaction of technology and individual learning as most interesting and possibly most meaningful to educators. Others have also suggested that current pedagogy is too lecture oriented and needs more creativity. For example, Albrecht and Sack (2000, p.43) suggest that, "accounting pedagogy often lacks creativity, involves too much lecture and dependence on textbooks, and does not develop the students' ability-to-learn skills. We are too bound by class time ..." Many instructors struggle to find an adequate balance of time and content coverage (depth and quantity). Hence, it is incumbent on faculty to find or develop creative or innovative tools that enhance course delivery and student learning.

While technology may be able to provide a more efficient course delivery alternative, little is known about its effect on the learner's cognitive skills. We seek to contribute to the narrowing of this gap in literature by presenting the results of an experiment carried out in order to determine the effect of using an interactive multimedia based instructional supplement [hereafter referred to as the MBIS] on the learner's cognitive skills. In the experiment, we use the MBIS as a tool to help students prepare for an accounting class lecture and assess its effects on learning using some of the cognitive domains as defined by Bloom's taxonomy.

The MBIS, an interactive video-based supplement, was used in this study to investigate whether the MBIS as a method of prior-to-class student preparation coupled with text-based reading material is more effective than the traditional read-the-textbook only method on enhancing the cognitive skills of the learner. More specifically, we aim to investigate whether a MBIS is effective in improving students' *remembering*, *understanding*, *applying*, and *analyzing* skills of the cognitive domain.

The primary motivation for developing the MBIS (see appendix 2) was to prep students for the upcoming in-class lecture by exposing them to a presentation/discussion of the concepts using everyday "student type" language. We believe this additional exposure would enhance business students' understanding of the interaction between financial accounting and business processes. Current financial accounting multimedia based supplements (most often textbook specific and usually accompanying a textbook) use technical terms and illustrations that are not much different than those in the textbook. The MBIS is designed to alleviate such a disconnection when used prior to in-class lecture/activities. Lipson and Fisher (2001) suggest that the observation of images such as in a MBIS is not, in itself, a powerfully sufficient learning device, although when combined with more direct methods of instruction, the required time for learning is decreased. This is one of the driving forces behind the MBIS.

A wider goal of such an additional learning supplement is to offer students greater opportunity for success in a course that many students deem very difficult. Traditionally, students taking introductory financial accounting struggle to successfully meet the course objectives. This results in high attrition and students repeating the course. Thus, if the use of an interactive MBIS can boost students' interest in the subject matter and improve student scores, then the overall effect would be improved learning of concepts and reduced attrition rates in the introductory financial accounting course. Moreover, we hope this study will increase faculty efforts to create excitement in the classroom and to develop delivery mediums that improve students' overall learning experience. While the interactive MBIS is only a delivery vehicle that moderates the interaction between visual and verbal aspects of learning, it can facilitate learning in a creative way that is attractive to the learner. The interactive MBIS provides the learner with the opportunity to incorporate visually rich illustrations into their instructional and learning processes. This means the MBIS has the opportunity to further engage the student in the course subject matter and increase the likelihood of helping the student learn and successfully meet course objectives.

Other empirical studies have sought to determine the effects of video instruction on learning (Choi and Johnson, 2005; Martin, Evans and Foster, 1995; Bryant and Hunton, 2000; Cognition and Technology Group, 1992; David, MacCracken and Reckers, 2003), but these studies do not analyze the integration of Bloom's (1956) taxonomy into learning with educational technology. For example, Choi and Johnson (2005) examined context based video instruction on learning (comprehension and retention). However, they used online masters degree students who were employed as lecturers and they used questions developed by Keller (1987) Instructional Materials Motivation Survey to define comprehension and retention. Additionally, Martin, Evans and Foster (1995) conducted a study on the use of videos in the teaching of accounting but the results were based on feedback from a student questionnaire, student's performance on the assignment and the reflection and comments of the academic staff involved in the innovation. Moreover, they failed to empirically define the measures used to assess the learning outcomes. While these studies are valuable, we seek to add more depth to the understanding of the use of videos and student learning by including Blooms' taxonomy (1956). Interestingly, prior studies have presented an overall effect, but not the specific skills impacted by the use of specific technology. Knowledge of the cognitive skills improved by the use of specific technologies is invaluable to educators who have a desire to enhance their students' learning experience. Hence, our study addresses the following research questions: Can multimedia based educational technology be an effective tool to improve student preparation and performance in accounting? And if so, what specific cognitive

skills are enhanced by the use of a multimedia based educational technology? In other words, will students using the multimedia based educational technology perform better than students not using the multimedia based educational technology?

Literature Review and Hypotheses Development

Educational Technology

The infusion of technology in the classroom continues to have an expanding role in academia. In a general sense, technology has been employed to help move beyond traditional, lecture-style teaching. In the past couple of decades, there have been many published studies regarding the use of technology in teaching. These studies all highlight the creativity and effective use of technology that is available for instructional delivery. These studies range from the effective use of course management software such as WebCT (Dunbar, 2004); use of videos on learning and motivation (Martin, Evans and Foster, 1995; Choi and Johnson, 2005), the use of artificial intelligence to guarantee individual effort (Goldwater and Fogarty, 2007), the integration of technology and business process analysis (David, MacCracken, and Reckers, 2003) and the effectiveness of multi-media presentations on student satisfaction (McVay, et al. 2008).

In many cases, the use of technology has afforded the opportunity to inject “real-world” aspect into teaching. In a study of real world case supplements in accounting information systems, Stanley and Edwards (2005, p. 23) suggest that traditional accounting teaching emphasizes, “... extracting essential principles, concepts, and facts, and teaching them in an abstract and decontextualized form.” They suggest that learning can be improved by adding an experiential learning component to traditional formal instruction.

Perhaps the most comprehensive overview of educational technology (ET) in accounting was written by Bryant and Hunton (2000). Their research discusses the pedagogical benefits of using technology in the classroom and seeks to encourage accounting education research in the area of education technology. Their study is seminal because it highlights research on both cognitive and behavioral theory from education and psychology and its impact on student learning. Based on these theories we believe instructional design and technology have the potential to create innovative and creative mediums that will improve learning. Indeed, current research suggests that interactive technology can increase student achievement (Dodds and Fletcher, 2004; Cavanaugh, 2001; Brown, 2004).

Bloom's Taxonomy

Benjamin Bloom (1956) viewed learning as a progressive process. Bloom's taxonomy is a classification of levels of intellectual behavior with three domains: cognitive, affective and psychomotor. The cognitive domain has six hierarchical positions of cognitive complexity. In 2001, Bloom's taxonomy was updated (Krathwohl, 2002). Ordered from least to the most complex, the revised cognitive domains are as follows: remembering, understanding, applying, analyzing, evaluating and creating. The levels are assumed to be cumulative, indicating that each level of the system builds on the successful completion of the previous levels. Figure 1 summarizes these cognitive levels. Research on Bloom's taxonomy has been found to transcend age, type of instruction and subject matter (Hill and McGraw, 1981; Kottke and Schuster, 1990; Kunen, Cohen and Solomon, 1981). Moreover, it is one of the most widely accepted models of cognitive abilities and has had a significant role influencing the understanding of learning outcomes (Kottke and Schuster, 1990).

According to the revised Bloom's taxonomy, students will first experience *remembering*, which is part of the first two levels (see Figure 1). Remembering suggests that the student can, “retrieve relevant knowledge from long-term memory” (Krathwohl, 2002, p. 215). The second level is *understanding*. At this level the student can, “determine the meaning of instructional messages” (Krathwohl, 2002, p.215). The third level is *applying*, in which the student can carry out or, “use a procedure in a given situation” (Krathwohl, 2002, p.215). The fourth level is *analyzing*, or differentiating, organizing or attributing material. The fifth level, *evaluating*, involves the student having the ability to make “judgments based on criteria and standards” (Krathwohl, 2002, p.215). The final and highest level of the revised Bloom's taxonomy, *creating*, involves the student having the ability to “put elements together to form a novel, coherent whole” (Krathwohl, 2002, p.215).

In this study we use the first four cognitive domains from the revised Bloom's taxonomy to determine the effectiveness of the MBIS in enhancing each cognitive skill. Such a relationship enables us to focus on effective teaching, not the technology. Davidson and Baldwin (2005) in their study on the original Bloom's cognitive skills in intermediate accounting textbooks found that very little of the learning activities, as reflected by end of chapter materials, focused on the two highest levels of Bloom's taxonomy. Since introductory accounting is a lower level course than intermediate accounting, it follows that introductory accounting is also likely to address only the first four cognitive domains. Consequently, since introductory accounting courses do not focus on learning at the highest levels of Bloom's taxonomy, only the first four levels of Bloom's revised taxonomy are used in this study.

Hypothesis Development

For years, researchers and educators have indicated that understanding learning theory is necessary to enhance the effectiveness of classroom instruction. The goal of education is for the student to learn the desired content. The use of technology and creative instructional delivery methods are merely the means to achieve the desired goal. Previous research has mixed results on the use of technology and its overall effectiveness in the classroom. For example, McVay et al. (2005) suggest that technology by itself may not be enough to support and transform pedagogy. Hagen et al. (1997) found that technology used in the classroom had positive results on students' satisfaction, participation and performance in a Strategic Management and Business Policy undergraduate course. Conversely, Rankin and Hoaas (2001) found that the use of PowerPoint presentations in an introductory Economics course did not affect students' performance or attitudes toward the course.

Given that technology alone is not enough to improve teaching effectiveness, it is important to understand what is. Both socio cultural theorist (Merriam and Caffarella, 1999) and constructivists (Jonassen, Peck, and Wilson, 1999) believe context based learning enhances learning. Socio cultural learning theory suggest that learning is not something that happens in isolation, or is it just inside the individual's head, but it is shaped by the context, culture and tools in the learning situation (Merriam and Caffarella, 1999). Thus, it is believed that the best learning environments exist where there are social relationships, tools, and engaged experiences. Constructivists believe that remembering cannot be simply transmitted from the instructor to the learner because the learner hasn't experienced what the instructor has. The learner's interpretation will be different because they have a different set of prior experiences (Choi and Johnson, 2005). Therefore, constructivists suggest that learning is a process of helping learners construct their own meaning from their own experiences and that information about the context is part of the remembering that is constructed by the learner (Jonassen, Peck, and Wilson, 1999). Given such, researchers argue that among all the various technologies that video technology is suitable for context-based learning since it can convey the information or remembering in a more interesting manner and because it allows the portrayal of more complicated contexts (Cognition and Technology Group, 1992). In addition, Jonassen, Peck, and Wilson (1999), suggest that stories in video can help learners easily understand and remember the content.

Moreover, video has the ability to use both audio and visual systems; this enables learners to construct mental representations from both visual and audio information. This combination provides additional and complementary information that helps the learner retain the characteristics from the origin (Baggett, 1984). Baggett (1984) also observed that information obtained visually was more memorable. Others suggest that video might be superior for learning complex skills because it can expose learners to problems, equipment, and events that cannot be easily demonstrated (Anderson, et al. 1989; Dusenbury, Hansen, and Giles, 2003). Indeed, research by the Cognition and Technology Group (1992) at Vanderbilt University suggest that multimedia based instruction is successful in enhancing students' problem-solving skills.

Based on the aforementioned research and Bloom's taxonomy and given that our MBIS is interactive and context based, we expect that it will have a positive effect on student learning resulting in better performance than if the student only had text materials to prepare for class. Consequently, the first hypothesis is as follows:

H1: *Students using the MBIS will outperform those using textual material only, based on the overall mean test SCORE.*

This hypothesis, if rejected, will give some indication as to whether student learning is positively impacted by use of an MBIS. However, it is much more interesting and useful to examine the concept of improved learning in more detail. As discussed in the literature review, a widely accepted view of learning is that there are various levels of learning. Bloom's revised taxonomy identifies those levels. Collectively, we made a judgment that an introductory accounting course addresses the first four levels, but usually not the top two levels. The Davidson and Baldwin (2005) study of end of chapter intermediate accounting materials complements this judgment as previously discussed in the literature review. Accordingly, we designed the test with questions directed toward the first four levels of Blooms' revised taxonomy (Krathwohl, 2002). The first four levels are remembering, understanding, applying, and analyzing. The three researchers of this study wrote and examined each question in the test and made collective judgments about which level of learning was tested by the question. There were three questions for each of the four levels of learning. This allowed a finer detail of analysis related to the first hypothesis.

It is important to determine if the results of testing the first hypothesis are driven by a single level of learning. For example, if students using the MBIS score significantly higher, it may be possible that it is attributed simply to improved memorization skills, *i.e.* remembering. Ideally, if an MBIS achieves the goals of its use, it should enhance learning at all four levels within Bloom's taxonomy. Thus, we developed four related hypotheses for the first four levels of the revised Bloom's taxonomy. Testing these hypotheses should allow us to determine if each level of learning is affected by the MBIS. The following are the four hypotheses that stem from Bloom's first four levels of learning:

H2a: *Students using the MBIS will outperform students without the MBIS on the portion of test scores measuring the REMEMBERING cognitive skill.*

H2b: *Students using the MBIS will outperform students without the MBIS on the portion of test scores measuring the UNDERSTANDING cognitive skill.*

H2c: *Students using the MBIS will outperform students without the MBIS on the portion of test scores measuring the APPLYING cognitive skill.*

H2d: *Students using the MBIS will outperform students without the MBIS on the portion of test scores measuring the ANALYZING cognitive skill.*

Research Method

Sample

The sample population consisted of 105 students enrolled in the Principles of Financial Accounting (introductory course) at a mid-western state university. One hundred eleven (111) students participated in the experiment but 6 did not complete all the required steps and were therefore dropped from the final sample of 105 students. Randomly selected sections were assigned as the treatment group ($n = 47$) while the rest were members of the control group ($n = 58$). Table 1, Panel A, shows a summary of the demographics. Fifty-five percent (55%) of the participants were female students. The mean self-reported age of the participants was 23 years (standard deviation = 5.166). Even though this course was labeled as a sophomore course, the majority of participants were juniors (42 percent) and sophomores (36 percent). Seniors made up only 17 percent of the participants. About 52 percent of the participants had an overall GPA less than 3.01, while only about 27 percent of the participants had an overall GPA greater than 3.51. The average overall GPA was 3.00 (standard deviation = 0.601).

Methodology

We use the posttest only control group design (Campbell and Stanley, 1963) where one group is administered the treatment while the other is not and then both groups are observed after the treatment is administered. In our experiment, students were randomly assigned to two groups – experimental and control group. The experimental (treatment) group received and used the MBIS to prepare for a prior-to-the-lecture quiz. The MBIS content included both the video and text-based reading material. The second group (the control) received traditional type material

(text only that included PowerPoint slides) for them to read in preparation for the same prior-to-the-lecture quiz administered to the experimental group. These materials were similar (look-n-feel) to the reading materials students normally used in preparing for class lectures (e.g. textbook, slides, or other notes accessible to students). The reading materials were also posted in Blackboard for any time access.

To enhance consistency, similar written instructions were read to the students in various sections instructing them to read the materials in preparation for the upcoming in-class lecture. Those instructions were also printed and handed to each student in case they wanted to refer to them later. Instructors were asked not to offer any further instructions. An important differentiating part of this experiment is the fact that the treatment group was given access to the MBIS that contained video segments explaining the same content as that in the reading material¹. The MBIS was posted on the web but access was given only to the treatment group. A more detailed description of the development and the administration of the MBIS is included in Appendix 2.

Prior to the planned in-class lecture on the same topic, all students were asked to complete a timed content-based online quiz (with similar content for both groups) based on the study materials given to them. Data was collected at various stages of the experiment as outlined in Figure 2. Other factors such as *students' academic ability, gender, class standing (maturity), and prior accounting knowledge* that were examined as covariates are discussed below.

Measures

Dependent variables:

In order to measure higher-order learning versus lower order learning we utilize the following learning behaviors (outcomes) as our dependent variables: *remembering, understanding, applying* and *analyzing* as described in Figure 1 above.

In addition to the dependent variables presented above, the first hypothesis is tested based on the overall mean *SCORE* that does not consider any variations in performance related to the various levels of cognitive skills. *SCORE*, therefore, is an additional dependent variable in this study.

Covariates:

Students Academic Ability (ABILITY): Participants' overall GPA levels were used to control for their academic ability that they brought to the experimental task. This variable was included because students who generally tend to achieve high grades overall will tend to do well in any environment regardless of the stimulus (Doran et al. 1991; Ravenscroft et al. 1997; Marcheggiani et al. 1999; Lancaster and Strand, 2001). Therefore, GPA is known to explain variation in student performance. In line with prior researchers (Doran et al. 1991) the GPAs were dichotomized into two groups. The group with GPAs of 3.00 or higher was coded as 1, while the group with GPAs below 3.00 we coded as 0

Gender (GENDER): By including the gender variable in our model, we sought to control for any gender effects. Prior research suggest that accounting students have an increasing preference for the convergent learning style (Brown and Burke, 1978); (Collins and Milliron, 1987) and that students with the convergent learning style perform better in an introductory financial accounting course than students with other learning styles (Togo and Baldwin, 1990). Moreover, Accounting students are more satisfied with courses from instructors with a convergent learning style (Geiger and Boyle, 1992) and that learning style differences can be gender related with male accounting students preferring "learning by thinking" and female students preferring "learning by watching" (Jenkins and Holley, 1991).

¹ To encourage the treatment group to watch the MBIS, they were told in advance that the ensuing quiz would include questions about the content of the MBIS.

Maturity (CLASS): We control for students' maturity level by their class standing. Class standing was found to be highly correlated with age ($r = .389, p = .000$) and therefore, the subject's class level is used to capture the maturity variable.

Prior accounting knowledge (PRIOR): To control for the effect of prior accounting knowledge, we asked the student participants two questions. The first question asked the subjects to indicate whether or not they had taken a financial accounting course before (including those repeating the course). The second question asked subjects whether they had any accounting based work experience and over how long they had gained such accounting experience. We considered students who had worked over one year as having prior accounting knowledge. We realize that the accounting experiences may have been varied or even limited and may not have exposed our subjects to the topic in the experiment but we believe that accounting experience at any level may predispose a student to other topics (issues) or even an interest in reading/watching business news. The covariate for prior accounting knowledge (PRIOR) was coded as 0 for none and 1 for a "yes" response to either of the two questions we asked.

Results

Hypothesis 1 – Differences in overall mean test scores

The first hypothesis examines the differences between the overall mean scores for the treatment group and control group without considering what specific cognitive skills are affected by the variations. A univariate analysis of variance was conducted with total quiz score (SCORE) as the dependent variable and GROUP (treatment versus control group) as the fixed factor along with the specified covariates (ABILITY, GENDER, CLASS, and PRIOR). Results in Table 2a indicate that the overall model is highly significant ($F(8285.902, 6) = 376.530, p = .000$). This result indicates that a significant proportion of the variation ($R^2 = 95.5\%$) in the dependent variable, SCORE, is explained by the fixed factor along with the covariates included in the model. As reported in Table 1, Panel B, the means for the overall total quiz scores (SCORE) point to the treatment group (mean score = 8.98) performing statistically significantly better ($p < .05$) than the control group (mean score = 8.74). Thus hypothesis 1 is supported as stated.

After controlling for covariates as shown in Table 2, panel B, GROUP is found to be a significant differentiating factor of student quiz performance ($p = .000$). This evidence further supports hypothesis 1. The covariates of ABILITY and GENDER were significant as well ($p = .01$ and $p = .003$ respectively). The positive ABILITY coefficient indicates that the higher the GPA, the better the students' SCORE (total score) on the quiz. On the other hand, the negative GENDER coefficient suggests that the male students performed better on the total quiz SCORE than the female students. No other covariates were significant in the model. We do not include nor discuss the intercept since it is not meaningful, as we have no information about quiz scores outside the range of the sample. In fact, our covariates cannot be modeled and interpreted as zero for gender or class. Brightman and Schneider (1994) offer a similar interpretation.

Many studies have relied on this method of using the total score (exam or quiz) as the dependent variable for reporting differential effects of technology and learning. We contend that merely using the overall total score yields useful information but it may not be as complete in providing an in-depth understanding of the actual skills enhanced by the MBIS. Much more information can be gained from further analysis as to the specific cognitive skills that are differentially enhanced by the use of technological supplements in accounting education. We therefore, contribute to existing literature by dichotomizing the quiz scores into four broad cognitive levels (based on Bloom's taxonomy): *Remembering*, *Understanding*, *Applying*, and *Analyzing*. We then perform a multivariate analysis of covariance test (MANCOVA) on subsequent hypotheses with these cognitive skills as multiple dependent variables. Since individual F tests ignore the correlations among the dependent variables, they use less than the total information available for assessing overall group differences. Hence, we conduct a multivariate analysis of covariance [MANCOVA] due to the inclusion of four covariates in the model. A covariate analysis is also appropriate in order to eliminate some systematic error outside the control of the researcher that may bias the results as well as to account for differences in the scores due to unique characteristics of the students. Our random assignment of students to the treatment groups also helped to minimize systematic error.

The four cognitive domains of *Remembering*, *Understanding*, *Applying*, and *Analyzing* are the dependent variables; GROUP (treatment versus control group) is the fixed factor, while ABILITY (GPA), CLASS, GENDER, and PRIOR knowledge are modeled as the covariates. A MANCOVA test of between-subjects for each model effect indicated that GROUP does significantly contribute to the model at the $p < .01$ level (Hotelling's Trace is 1.488 and Roy's Largest Root is 1.396). The results for GENDER and ABILITY suggested that these two covariates are correlated with some dependent variables, and therefore do contribute significantly to the model at the $p < .05$ and $p < .10$ levels respectively. ABILITY is significantly correlated with UNDERSTANDING ($p < .01$), while GENDER is significantly correlated with ANALYZING ($p < .01$). On the other hand, CLASS and PRIOR each have equal results for Hotelling's Trace (value is .012 and .064 respectively) and Roy's Largest Root (value is .012 and .064 respectively), suggesting that these two variables do not contribute much to the model.

Having found that the dependent variables (cognitive skills) vary between the groups, the multivariate tests of between-subjects effects, as shown in Table 3, was used to specifically identify the magnitude of the factor effects on the various dependent variables. As shown in Table 3, the overall model is significant at $p < .001$ at each dependent variable level and no less than 85% of the variance is explained by the hypothesized model (the smallest adjusted R^2 is 85.4%). This means they are not so highly intercorrelated that there were no unique group differences contained in each cognitive skill even after the effects of each skill were accounted for. The results for hypotheses 2(a) through 2(d) are discussed below and presented in Table 3.

Hypothesis 2a - Differences in overall mean test scores for REMEMBERING

While a test of between-subjects for each model effects reveals that the group in which the student belonged to in the experiment (treatment or control group) made a significant contribution to the model (Pillai's trace = .666; $F(12.112, 8, p < .001)$), a test of between-subjects effects (Table 3) points to the specific cognitive domains where the individual scores differed between groups.

Hypothesis 2(a) tests whether students using the MBIS will outperform those using textual material only, based on their individual test scores on REMEMBERING. We find that the group in which the student belonged to in the experiment had a significant main effect on their score on the REMEMBERING domain, $F(32.844, 2) = 47.655$, $p < 0.01$ (see Table 3). As shown in Table 1, Panel B, students placed in the control group averaged a score of 2.72, significantly higher than those students in the treatment group (mean score is 2.49), hence hypothesis 2(a) is not supported as stated. No other main effects (covariates) contributed significantly to the difference in the REMEMBERING score between the treatment and control groups.

Hypothesis 2b - Differences in overall mean test scores for UNDERSTANDING

Hypothesis 2(b) tests whether students using the MBIS will outperform those using textual material only, based on their individual test scores on understanding. After controlling for prior knowledge, class, and gender, results of between-subjects effects in Table 3 show a significant difference between the UNDERSTANDING scores for the treatment group when compared with the control group where $F(21.001, 2) = 14.939$, $p < .001$. The mean UNDERSTANDING scores reported in Table 1, Panel B, for the treatment group (2.32/4.00) and control group (2.12/4.00) reveal that the treatment group performed significantly better than the control group. Thus hypothesis 2(b) is supported. The students' ABILITY also had a significant effect ($F(6.006, 1) = 8.545$, $p < .01$) on students' understanding. ABILITY and UNDERSTANDING are significantly correlated ($p < .005$) suggesting that the higher the student's ability the higher the UNDERSTANDING score. An independent samples test of equal means for ABILITY (GPA levels) between the two groups did not yield a statistically significant difference. This result is expected since student assignment to the two groups was completely random. The mean scores shown in Table 1 indicate that students in the treatment group scored higher than those in the control group, lending support to the conclusion that the multimedia based instructional supplement did help to enhance the students' understanding cognitive skill. No other covariates had a significant effect on UNDERSTANDING.

Hypothesis 2c - Differences in overall mean test scores for APPLYING

Hypothesis 2(c) tests whether students using the MBIS will outperform those using textual material only, based on their individual test scores on APPLYING. Results of between-subjects effects in Table 3 show a significant difference between the APPLYING scores for the treatment group when compared with the control group where $F(23.196,2) = 19.680, p < .001$. The mean APPLYING scores for the treatment group (2.26/4.00) and control group (2.02/4.00) in Table 1 reveal that the treatment group performed significantly better than the control group. Thus hypothesis 2(c) is supported as stated. Inclusion of GENDER in the APPLYING model has a moderately significant effect $F(2.377,1) = 4.034, p < .10$. No other covariates had a significant effect on APPLYING.

Hypothesis 2d - Differences in overall mean test scores for ANALYZING

Hypothesis 2(d) tests whether students using the MBIS will outperform those using textual material only, based on their individual test scores on ANALYZING. After controlling for prior knowledge, class, and gender, results of between-subjects effects in Table 3 show a significant difference between the ANALYZING scores for the treatment group when compared with the control group where $F(30.424,2) = 24.247, p < .001$. The mean ANALYZING scores shown in Table 1, Panel B, for the treatment group (1.91/4.00) and control group (1.88/4.00) reveal that the treatment group performed significantly better than the control group. Thus hypothesis 2(d) is supported as stated. The GENDER variable in the ANALYZING model has a significant effect $F(7.864,1) = 12.535, p < .005$. GENDER and ANALYZING are significantly correlated ($p < .01$). The negative correlation suggests that the male student outperformed the female students on the ANALYZING score. Further research is warranted in order to fully appreciate this finding. We found no other significant group related contributory effects. The ANALYZING results in Table 3 show that the inclusion of PRIOR in the model is significant $F(3.169, 1) = 5.051, p < .05$. However in a test of between-subjects effects, the overall model effects indicated that PRIOR and CLASS did not contribute much to the model as evidenced by a low Pillai's Trace (0.12) and a very high Wilks' Lambda (.988). Hence we choose not to give it a weightier interpretation.

Discussion And Implications

When overall test scores are evaluated without consideration of the cognitive skills being affected, the results may be partially useful or they may offer information that is not as complete. Even though our results indicate a statistically significant difference between the total mean scores for treatment group and the control group when only the total score is analyzed, significant differences are noted between the groups with the treatment group outperforming the control group when the total mean score for the groups is dichotomized into four cognitive skills. These results suggest that analyzing total scores without further consideration of the cognitive skills being enhanced offers insufficient evidence to make conclusive statements about the actual role of technology in accounting education. While overall total based results offer great insights, we believe more information can be gained from further analysis as to how technology impacts student learning. This study further dichotomizes the total score into four cognitive learning domains of remembering, understanding, applying, and analyzing.

While hypothesis 2a was not supported as stated, the significant difference of the control group outperforming the treatment group in the remembering cognitive skill presents an interesting observation. Bloom's taxonomy defines the remembering cognitive skill as including any question that requires only the retrieval of information from memory. This skill is often associated with questions that require definitions, identification, listing, matching, remembering, recall of information, etc... The experiment offered the treatment group a multimedia based supplement that presented information in video format as well as the same text-based reading material given to the control group while the control group was offered text-based reading material only and not the MBIS. While the treatment group was expected to watch the video and read the text material, the experimental design could not guarantee that the reading was definitely done by the treatment group as part of the experiment even though incentives to do so were in place. It is, therefore, possible that the control group paid a lot more attention to its reading assignment than the treatment group since it had no other source of information. If this were true, then these results reveal that a multimedia based supplement by itself would not enhance learners' remembering cognitive skills more than that gained from text-based reading only. This anecdotal evidence calls for a more rigorous (controlled) experiment in order to arrive at a definitive conclusion.

Results point to a significant improvement in understanding, applying and analyzing cognitive skills of the group that used the MBIS over the group that relied totally on text-based reading. Intuitively, it is interesting to note that the students with a higher GPA (ABILITY) scored statistically higher on the UNDERSTANDING cognitive skill. Interestingly, the male students outperformed the female students in the ANALYZING cognitive skill.

Overall, the findings of this study indicate that the use of a multimedia based instructional supplement as a student learning tool appears to enhance student performance related to specific cognitive skills and at various levels of student ability, and gender. As such, even students who are not necessarily intrinsically interested in the course topics or students who may not have very high achievement ability may benefit from the availability of such a learning tool. The results also point to the need for faculty to find ways of enforcing the use of both the technological supplement and text-based reading in order to reap the maximum benefits at various cognitive skill levels. These results are consistent with other studies that show media alone does not influence all learning (Thompson et al. 1992); Clark, 1983; 1994). Lipson and Fisher (2001), for example, suggest that the observation of images (such as in a MBIS) is not, in itself, a powerfully sufficient learning device, although when combined with more direct methods of instruction, the required time for learning is decreased. Overall, these findings suggest that educators could benefit from a concerted effort to incorporate use of cognitive skill-targeted technology in accounting (or business) education in order to enhance specific learning. In addition, models that seek to explain the interaction of technological innovations in the classroom and student learning should explore further beyond the one catch-all dependent variable (mostly a total test score) in order to explain the actual skills enhanced by use of the technological innovation.

Limitations

While great measure was taken in the design and control of the experiment, our conclusions and findings may be subject to several limitations, which can weaken our generalizations. First, it is unintentionally possible that the design of the MBIS or the design of the text-based reading material could be biased to a particular cognitive skill. Such bias, if it existed, would not have been easily detected or isolated in this experiment or in the results. The question of whether achieving a consistent design in the material is a necessary procedure is one for further investigation. Second, greater control may have been necessary to ensure that the treatment group did actually read the text-based reading and did not just rely on the MBIS to answer the questions. Efforts were taken to evaluate whether students used the material given to them in the experiment. After the in-class lecture, all students (both the treatment and control group) were asked to watch/review the MBIS at their own time and respond to questions relating to their “after-video-and-class lecture” experience. Their responses to this survey showed that students not only enjoyed the experience but also thought the material was very effective in the learning process. We also could not control for any possible defiant participant who may have knowingly or unknowingly shared treatment group information. Future experiments should emphasize a more controlled environment in order to diminish this limitation. Third, the MBIS used in the experiment presented only one topic (stockholders’ equity). It is not clear whether similar results would emerge under other topics since they all vary in difficulty level. It is possible that other topics may yield varying results. Future studies can provide more light on this limitation and determine which course topics can best be used with technology delivery mediums in order to enhance student learning and their cognitive domains. Fourth, while overall GPA has been used in other studies as a control variable for participant ability, it is not clear whether the varied circumstances under which the various GPAs were earned would have a significant difference in our findings. Even with these limitations, we believe this study advances our understanding of the importance of using technology in the classroom and what role technology has in enhancing student learning and cognitive skills.

Conclusion

The overall results of this study support the generally held belief that student learning can be enhanced by the use of technology. This study extends this belief by demonstrating that the use of technology in the classroom can enhance student understanding, applying, and analyzing levels of cognitive skills. These findings should encourage faculty to continue to design creative classroom activities that utilize technology and to engage students in order to improve their cognitive skills.

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APPENDIX 1
Quiz Questions Grouped Into Cognitive Domains

“Remembering” Questions

1. The number of shares of common stock that have been sold is the number of:
 - a. Authorized shares.
 - b. Issued shares.
 - c. Outstanding shares.
 - d. Treasury stock shares.
2. When placing retained earnings on a financial statement, it would be included as part of the:
 - a. Assets.
 - b. Revenues.
 - c. Liabilities.
 - d. Equity.
3. Issued stocks that are repurchased by the issuing company are called:
 - a. Authorized shares.
 - b. Issued shares.
 - c. Outstanding shares.
 - d. Treasury stock shares.

“Understanding” Questions

4. Which of the following is not true of the par value of a stock?
 - a. It is the minimum price attached to each share of a share of stock.
 - b. It is the minimum price authorized by the state.
 - c. It is related to the market value of the stock.
 - d. Conceptually, it is the same as the stated value of a stock.
5. Which of the following is not true of retained earnings
 - a. It is a measure of the amount of cash in the business.
 - b. It is part of stockholders' equity.
 - c. It represents profits reinvested in the business.
 - d. It is reduced when dividends are paid.
6. The main concept of retained earnings is that it represents:
 - a. Cash retained in the business.
 - b. Earnings set aside for a specific purpose.
 - c. Amounts paid by stockholders to purchase company stock.
 - d. Accumulated profits that have not been distributed as dividends.

“Applying” Questions

7. Butler Corporation was incorporated in Ohio in 1998, At the date of incorporation, the corporation was granted legal rights to sell shares of common stock up to 2 million shares. Since 1998, the company sold 1,400,000 shares to stockholders and repurchased 200,000 shares. Currently, the number of shares issued is:
 - a. 2,000,000.
 - b. 1,600,000.
 - c. 1,400,000.
 - d. 1,200,000.

8. If Wasatch Corporation sells 1,000 shares of \$2 par value common stock at a price of \$5, the equity section of the balance sheet will:
 - a. Increase by \$5,000.
 - b. Decrease by \$5,000.
 - c. Increase by \$2,000.
 - d. Decrease by \$2,000.

9. Benning Corporation has been operating for two years. In 2004, it had a loss of \$50,000. In 2005, it earned a profit and \$80,000 and paid dividends of \$20,000. The balance in Retained Earnings at the end of 2005 is:
 - a. \$80,000.
 - b. \$60,000.
 - c. \$30,000.
 - d. \$10,000.

“Analyzing” Questions

10. When a corporation has a positive profit in a given year, the most likely effect of the balance sheet of the profit is:
 - a. A decrease in equity and a decrease in assets.
 - b. An increase in equity and a decrease in assets.
 - c. A decrease in equity and an increase in assets.
 - d. An increase in equity and an increase in assets.

 11. When a sells shares of common stock in a given year, the most likely effect of the balance sheet of that sale is:
 - a. A decrease in equity and a decrease in assets.
 - b. An increase in equity and a decrease in assets.
 - c. A decrease in equity and an increase in assets.
 - d. An increase in equity and an increase in assets.

 12. If Butler Corporation purchases 5,000 shares of treasury stock at a cost of \$40 per share, the effect on assets and equity would be:
 - a. \$200,000 decrease in equity and \$200,000 decrease in assets.
 - b. \$200,000 increase in equity and \$200,000 decrease in assets.
 - c. \$200,000 decrease in equity and \$200,000 increase in assets.
 - d. \$200,000 increase in equity and \$200,000 increase in assets.
-

APPENDIX 2

Development and Administration of the Multimedia-based Instructional Supplement (What was done?)

Guiding Principles - Using the guidelines outlined by Bryant and Hunton (2000), we developed an interactive multimedia based instructional supplement as a tool to prepare students for an in-class lecture. Bryant and Hunton (2000) suggest the following for effective use of technology in instructional design:

1. to provide opportunity for student interaction (student involvement)
2. to present accounting using basic and everyday language in explanations
3. to clearly state objectives at the beginning of each topic
4. to provide feedback to the student for monitoring self-progress
5. to incorporate students' prior knowledge in its design
6. to keep it interesting enough to motivate completion

Bryant and Hunton (2000) classify educational technology by two major types, Computer-Based Learning (CBL) and Other Technologies with sub-categories in each. Our MBIS in this study combines characteristics of the two types. The MBIS included a video in which accounting and business students presented a real-world business situation. Thus, the MBIS incorporated parts of TV and Film, and Computer Assisted Instruction. The MBIS was unique in that it combined these two parts and provided them to students in a manner that students could view the video and accompanying multimedia presentations at a time of their own choosing, and at a pace that accommodated their needs. That is, the MBIS was an interactive self-paced learning supplement. Since the MBIS was an executable computer program, the student could run it on his/her own computer with the option of stopping or starting it as desired.

Script - Having taught the course repeatedly for many years, one of the co-authors prepared the script based on the expected concept coverage for the course. The script preparation went through several iterations to ensure adequate coverage of the intended objectives. Junior level business and accounting students were selected and coached extensively on the expected quality of their presentation (role play). Two of the authors were actively involved during the actual process of studio video recording at the university studio. Other material prepared included a written script, hard copy of the power point slides and a self-driven interactive quiz.

Procedure - As is found in a normal learning environment, both the treatment group and the control group were given text-based reading material that included PowerPoint slides as well as textual notes to accompany the slides. A differentiating part of this experiment is the fact that the treatment group was also given access to the MBIS that contained interactive, self-executing computer program with video segments explaining the same content as that in the reading material. The MBIS was posted on the web but only the treatment group was given the URL for access. Overall, both groups' received the same material with the only difference being the MBIS given to the treatment group as a tool for study. Prior to the planned in-class lecture on the same topic, students were asked to complete a timed content-based online quiz (with similar content for both groups). As an incentive for full participation, students were promised a maximum of 10 bonus points in the course (total points = 600 for the course) for successfully completing all the tasks involved in the study. In order to encourage students to treat the tasks with a high level of seriousness, the students were told that they would need to score at least 7/12 points on the quiz in order to earn the maximum bonus points. To encourage greater engagement in the experiment, students were told that scores of less than seven points would receive prorated bonus points. This requirement was removed (dropped) after the deadline for completing the online quiz in order to encourage all participants to complete the remaining parts of the experiment without a penalty for not achieving the required seven points. That means that all participants were eligible to receive the full bonus points regardless of their performance on the online quiz. After completing the online quiz (and prior to attending the class lecture on the same topic), students were asked to log into an online survey that solicited responses to demographical type information. At this point the students were ready for their in-class lecture discussing the same topic read/viewed prior to class attendance. After the in-class

lecture, all students (both the treatment and control group) were asked to watch/review the MBIS at their own time and respond to questions relating to their “after-video-and-class lecture” experience.

Several measures were taken to ensure an appropriate level of efficiency and internal validity of the experimental procedures as follows:

1. Since the MBIS was intended for use by students in preparing for the in-class lecture, the experiment commenced a week before the scheduled date for the related in-class lecture.
2. The MBIS was deposited on the web but its existence there was not readily visible. The URL was given to the treatment group only. The treatment group was also instructed not to share the URL with other sections of the course in order to avoid any confusion as to what they were supposed to do to earn their bonus points.
3. The selected topical content of the material to be studied as part of the experiment related to non-overriding concepts. This design controlled (to a large extent) for the possibility that students’ success on the quiz was based on prior knowledge and not on efforts associated with the experimental task.
4. The content-based online quiz was timed at 15 minutes maximum once accessed. Access to the quiz was restricted to only once. The overall score was reported to the student as soon as the quiz was submitted but neither the specific questions nor the answers were revealed to the students immediately upon completion of the quiz. These details were released after the deadline (time) for taking the quiz by all participants.
5. To ensure accuracy in the script and the produced video, several faculty in the department of accounting were asked to view the MBIS and provide feedback to the authors. Comments received were incorporated in subsequent processes.
6. To ensure consistency in the delivery of instructions given to all participants (as appropriate for experimental and control groups), a written script of instructions was provided to each instructor. The instructors were specifically told to adhere to only the supplied script in providing information to their students regarding the experiment.
7. To reduce the chance of the control group having access to the MBIS, participants in the treatment group were not selected from the same class as the participants in the control group.

Table 1
Descriptive Statistics

Panel A: Respondents Profile							
		N	Cumulative Percent				
Group	Control	58	55%				
	Experiment	47	100%				
Gender	Female	58	55%				
	Male	47	100%				
Class	Sophomores	38	36%				
	Juniors	44	78%				
	Seniors	18	95%				
	Other	5	100%				
				Minimum	Maximum	Mean	Standard Deviation
Age	Below 21	36	34%	18	49	23	5.166
	Below 25	51	83%				
	Below 31	10	92%				
	Below 50	8	100%				
GPA	<= 2.00	5	5%	1.44	4	3	0.601
	2.01 – 2.50	17	21%				
	2.51 <= 3.00	33	52%				
	3.01 – 3.50	22	73%				
	3.51 – 4.00	28	100%				

Panel B: Scores on Dependent Variables				
		N	Mean	Standard Deviation
Remembering	Control	58	2.72	.451
	Experiment	47	2.49	.718
Understanding	Control	58	2.12	.900
	Experiment	47	2.32	.810
Applying	Control	58	2.02	.737
	Experiment	47	2.26	.820
Analyzing	Control	58	1.88	.839
	Experiment	47	1.91	.855
Score	Control	58	8.74	1.802
	Experiment	47	8.98	2.298

Table 2
Univariate Analysis of Covariance with Total Score as Dependent Variable

Panel A: Analysis of Covariance					
Source	DF	Sum of Squares	MS	F	p-value
Between	6	8285.902	1380.984	376.530	.000
Within	99	363.098	3.668		
Total	105	8649.000			
Adjusted R ² = 95.5%					
Panel A: Analysis of Covariance					
Variable	Coefficient	Std. Error	t-statistic	Significance	
Ability	1.016	.386	2.634	.010	
Gender	-1.174	.385	-3.048	.003	
Class	.207	.215	.963	.338	
Prior	-.466	.383	-1.217	.226	
Group (control)	9.801	.940	10.424	.000	
Group (experimental)	9.906	.954	10.386	.000	
Alpha = .05					

Table 3
MANCOVA Tests of Between-Subjects Effects

Source	Dependent Variable	Sum of Squares	Df	F	Significance	Adjusted R-Squared
Model	Remembering	722.884	6	349.618	0.000	0.952
	Understanding	520.411	6	123.393	0.000	0.875
	Applying	478.656	6	135.365	0.000	0.885
	Analyzing	388.890	6	103.311	0.000	0.854
Group	Remembering	32.844	2	47.655	0.000	
	Understanding	21.001	2	14.939	0.000	
	Applying	23.196	2	19.680	0.000	
	Analyzing	30.424	2	24.247	0.000	
Ability	Remembering	0.690	1	2.004	0.160	
	Understanding	6.006	1	8.545	0.004	
	Applying	1.216	1	2.063	0.154	
	Analyzing	0.435	1	0.693	0.407	
Gender	Remembering	0.264	1	0.766	0.384	
	Understanding	0.956	1	1.360	0.246	
	Applying	2.377	1	4.034	0.047	
	Analyzing	7.864	1	12.535	0.001	
Class	Remembering	0.018	1	0.051	0.821	
	Understanding	0.095	1	0.136	0.714	
	Applying	0.458	1	0.777	0.380	
	Analyzing	0.527	1	0.839	0.362	
Prior	Remembering	0.182	1	0.529	0.469	
	Understanding	0.003	1	0.005	0.945	
	Applying	0.004	1	0.007	0.932	
	Analyzing	3.169	1	5.051	0.027	
Error	Remembering	34.116	99			
	Understanding	69.589	99			
	Applying	58.344	99			
	Analyzing	62.11	99			
Total	Remembering	757.000	105			
	Understanding	590.000	105			
	Applying	537.000	105			
	Analyzing	451.000	105			

Figure 1
Description of Levels of the Revised Bloom's Taxonomy

	Level (Dependent Variable)	General description of task
1.	Remembering	Retrieving relevant knowledge from long-term knowledge
2.	Understanding	Determining the meaning of instructional messages
3.	Applying	Carrying out or using a procedure in a given situation
4.	Analyzing	Breaking material into constituent parts and detecting how parts relate to one another and to an overall structure
5.	Evaluating*	Making judgments based on criteria and standards
6.	Creating*	Putting elements together to form a novel, coherent whole or make an original product

* These levels (dependent variables) are not included in this study

Figure 2
Stages of Data Collection

Steps/Procedures	Treatment Group	Control Group
Read textual material – emailed to subjects and posted in Blackboard	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Watch MBIS – treatment group was given the URL for access	<input checked="" type="checkbox"/>	
Take a timed content-based online quiz in Blackboard	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Respond to an online survey - demographical information	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Attend in-class lecture on same topic read/viewed	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Watch the MBIS	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Respond to “after-video-and-class” experience	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>