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Accounting Education and Reform: A Focus on Pedagogical Intervention and Its Long-Term Effects

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Abstract

The purpose of this study is to assess the extent technology based pedagogy (TBP) contributes to student performance and how information obtained about this linkage can be employed to guide accounting education reform. To do so, we measure the predictive ability of TBP on performance in the first Financial Accounting course (Financial I) over time. We then compare the performance of students exposed to TBP to those who have not. A key component of our investigation controls for demographic variables. Our results offer evidence TBP positively affects performance over the long term and that this effect is not diminished by the presence of demographic variables.

Introduction

The purpose of this study is to assess the extent technology based pedagogy (TBP) contributes to student performance and how information obtained about this linkage can be employed to guide accounting education reform. This inquiry is important for four reasons. First, evidence suggests accounting education reform has attracted a high level of interest across communities (Albrecht and Sack 2000; Catanach et al. 2000; Donelan and Reed 1992; Russell et al. 2000; and Barsky et al. 2001). In these communities, several approaches have arisen to deal with reform, but critics describe these efforts as fragmented or non-comprehensive (Frederickson and Pratt 1995; Barefield 1991; Barsky et al. 2003; and Dosch et al. 2006). Moreover, Siegal et al. (2010) indicate significant gaps exist between what accounting educators teach and what practicing accountants do.

Second, a very real issue facing reform is that it is multi-faceted in that one has to consider the varied inputs (i.e., student, pedagogy and environment) of the education production function to make reform value-adding (Frederickson and Pratt 1995). As such, suggested approaches include creating a foundation to address reform efforts across time, pedagogy, and learning and teaching environments (Gow et al. 1994; English et al. 2004).

Reforms should also highlight how and why improved learning occurs when students process and re-process information they previously gained to inform future learning. Finally, efforts to support reforms adopted should focus on indicating results can sustain over time, especially in relation to how learning reacts to pedagogical choices made by an instructor as learning contexts change (Jackling 2005a and 2005b).

Third, current research indicates that active engagement promotes learning whereby students are stimulated to participate in creating their own learning agendas (Hand et al. 1996). Evidence also suggests employing active learning to promote students to "learn to learn" and gaining insight about how students learn in varied contexts are equally important (Jackling 2005a; Adler and Milne 1997b). Indeed, it may be that learning environments, and the pedagogy adopted to accompany them, promote individualized thinking and thus, improve academic outcomes (Entwistle 1991). Moreover, given the aim of education is to promote conceptual learning, identifying educational climates that facilitate motivated and focused learning is of central importance (Benware and Deci 1984).

Finally, reform should facilitate current and future general, academic, and professional knowledge (AECC 1990). One area many suggest needs more attention is how technology can shape learning and the acquisition and use of knowledge (McDowall and Jacking 2006; Ahadiat 2008; Bryant and Hunton 2000; Peng 2009; Al-Khadash and Al-Beshtawi 2009; Togo and McNamee 1995). In particular, there are specific concerns accounting education is not doing enough to include the use of technology in its curriculum (Albrecht and Sack 2000). This is important because the use and application of technology in the profession is growing.

For instance, the extent to which technology based innovations are changing the focus of professional accounting has removed traditional communication borders and redefined working relationships (Drew 2012; Tysiac 2012). In addition, the extent to which the presence of technology awaits our students upon graduation looms large. This latter observation takes into account the extent to which technology based activities have guided this current generation of students to do very little without the use of electric mediums (Gaffney et al. 2010). With such evidence, constructing reforms absent an attention to the role technology plays may be of little value.

In this study, we have adopted technology and it's interaction with pedagogy to assess TBP effectiveness and, herein, it's potential to provide input to a reform agenda. We make use of TBP because the use of technology in the accounting profession is expansive. Our study is unique in that we evaluate the infusion of technology based on how it adds value to student learning. Based on a premise that student learning styles are affected by tasks one is asked to complete, we evaluate whether a pedagogy that is based on student self-directed engagement brought on by pedagogies that employ technology as a mode of instruction create or promote differential student outcomes. Under this perspective, and as denoted by Orlikowski (1992), technology acts a material trigger that intervenes the relationship between humans and the structures imposed on them. In addition, in constructing our setting and view of technology in this manner, we are addressing the observation that it is the failure of accounting education to change and develop pedagogies that actively involve students that is the real contributing factor for the lack of efficacy in accounting education today (Adler and Milne 1997a). Guided by these observations, then, it is the pedagogy (i.e., the TBP structure), its impact on learning, and subsequently, its effect on student outcomes that is our real query. Addressing our query over time responds to calls for a need to gather past and current information about student performance to draw value adding inferences about the effectiveness of learning pedagogies and how their relationships with teaching environments and student learning styles might guide reform (Adler and Milne 1997a).

This paper seeks to assess the effects of TBP on student performance by examining this link as related to the first Financial Accounting (Financial I) course. Following previous work, we assess this effect in the presence of other demographic and environmental variables known to affect performance (Bryne and Flood 2008; Eikner and Montondon 2001; Frakes,1997; Turner et al. 1997); Didia and Hasnat 1998). We also examine effects over time via discrete intervals to ensure the complete impact of TBP is captured.

Our results show that after controlling for the demographic and environmental variables known to affect performance, TBP impacts performance over time. The results of this paper lead us to infer an effective approach to accounting education reform requires more information about how the use of technology based pedagogies increase ability, capacity, and desire to learn and how these outcomes work together to improve student performance. We suggest one way to achieve this objective is to focus on curriculum and instructional models that are all-inclusive and sensitive to the impact time has on the ability to learn.

Literature Review and Motivation

Challenges of Accounting Education Reform: Past, Present and Future

A very real challenge related to accounting education reform implementation is that it is a multi-faceted process (Albrecht and Sack 2000; Frederickson and Pratt 1995). A value adding approach to reform is to start with gaining an understanding of students and the environments in which they reside (Frederickson and Pratt 1995). In addition, reform must be guided by the objectives it is trying to accomplish (Adler and Milne 1997b). Reform also requires information be gathered about how students learn and process information, and how they can use what they have learned to improve future learning (Monsanto et al. 2004). Finally, reform efforts should include an evaluative component to measure the extent education reform interventions enhance learning to a greater degree than traditional or previous approaches (Chu and Libby 2010).

Seminal to the last observation is the need to evaluate outcomes based on learning context and approaches (Reeves 2000). In addition, accounting education reform has been criticized for trying to create, evaluate, and implement outcomes without fully understanding how a student has been affected by the learning that associates with an intervention and the environment in which the intervention takes place (Du and Wagner 2005; English et al. 2004). Failure to recognize this link contributes to the lack of understanding of the determinants of high level learning outcomes which impedes the development of value adding accounting reforms (Byrne eta al. 2002).

Active verses Passive Participation

Learning is not merely a mental, intellectual, or behavioral process but rather, is a process that improves outcomes by relying on how a student: 1) creates knowledge; 2) reacts to the learning environment; 3) relies on prior learning experiences; 4) uses the tools provided to learn; and 5) incorporates the teaching strategies and pedagogies of the instructor (Bryne et al. 2002). Effective learning techniques recognize past knowledge shapes future knowledge and promotes an ability to figure out how things work now and in the future; in essence, the learner needs to be given the chance to develop over time (Adler and Milne 1997a). Adopting reforms using this approach as a guide addresses the need for educators to select reforms that add value (Reeves 2000).

Existing accounting education reviews and frameworks contend classroom pedagogies should promote the development and maintenance of life-long learning skills (Cottell and Millis 1993; AAA 1986; AECC 1990). Under this rubric, chosen pedagogical methods promote learning by engaging students to think about what they learn and to recognize how to use what they have learned to continue to learn (AACSB 2105). Herein, students are active participants who identify problems, search out information pertinent to the problems, evaluate information usefulness, and make decisions between competing alternatives. The challenge of reform, then, is to modify or enhance pedagogy to foster an appreciation for learning and the ability to continue to learn (Bolt-Lee and Foster 2003).

These observations are prevalent in more recent approaches to accounting education reform. For instance, in its eligibility procedures and accreditation standards for accounting accreditation, the Association to Advance Collegiate Schools of Business (AACSB) advocates the need to promote long term learning and to engage students in active learning (AACSB 2015). Albrecht and Sack (2000) suggest promoting this agenda is necessary as current accounting education fails to develop a student's "ability-to-learn" due to inappropriate or mis-specified pedagogies. Moreover, the authors contend the current focus to master content knowledge is outdated and non-transferable. Instead, they suggest the focus of pedagogies should be to develop critical thinking skills that increase knowledge. Boyce (2004) concurs and suggests a more appropriate approach to improve student knowledge is to recognize that when teaching accounting, all types of learning takes place. Indeed, AECC (1990) notes accounting education reform must understand accounting graduates possess general, organizational, and accounting knowledge and any effective accounting education reform model must take all three into consideration.

Clearly, these observations indicate accounting education reform is influential when the conditions or contexts in which students learn are considered. Associatively, Adler and Milne (1997b) concur that the failure of accounting educators to recognize and cope with the need to promote wider knowledge engagement and development is a real problem. As they see it, absorbing students into the learning process is vital to alleviating this condition. Thus, one key ingredient of effective accounting education reform is to consider strategies that invite active engagement to promote a higher and more sophisticated concept of learning that allow students to develop linkages between existing and developing knowledge bases (Alder and Milne 1997a).

The result is a student centered approach to learning where adopted pedagogies reflect an orientation that moves away from the perspective that students are merely the recipients of instruction. Instead, the student centered approach positions students for a more active role in their own learning process by constructing their own knowledge through the acquisition and application of new skills and concepts that surface because of the pedagogy selected (Potter and Johnston 2006). Consequently, both active engagement and a deep appreciation of problem-based learning will emerge (Lucas 1997).

The framework described above is active learning, an instructional method that engages students in the learning process and requires them to think about what they are doing (Prince 2004). Active learning, as described by Bonwell and Eison (1991), encompasses seven characteristics: 1) students are involved in more than passive listening; 2) students are engaged in activities; 3) there is less emphasis placed on information transmission and greater emphasis on developing skills; 4) there is greater emphasis placed on the exploration of attitudes and values; 5) students can receive immediate feedback from their instructor; 6) student motivation is increased; and 7) students are involved in higher order thinking.

Active learning promotes reflective learning or the capacity to learn on a much deeper level by drawing on problem solving experiences (Lucas 1997; Carter and Jones 2011) and is based on developing a set of building blocks where current and future learning is shaped, directed, and guided by past learning experiences. The value created via active learning is the acquisition of knowledge based on learners taking both control and responsibility for learning and making choices to involve themselves in decisions as to what and how they will learn (Adler and Milne 1997b). Outcomes of active learning include increased knowledge, improved attitudes, and heightened academic results (Matherly and Burney 2013).

Research relative to the inclusion of active learning in accounting pedagogy suggests it has merit. Hermanson (1994) finds active learning a key contributor to a student's ability to generate reasonable explanations in business. In addition, the author finds active learning facilitates the link between new and existing knowledge and motivates recall. Cottell and Mills (1993) indicate active learning allows faculty to address accounting education reform by adopting creative and innovative methods that strengthen teaching and improve educational outcomes. Springer and Borthick (2007) indicate active learning allows a student to decipher what is being learned, reflect on what works, and to discover improvements. Finally, Chu and Libby (2010) suggest active learning allows students to take ownership of knowledge and use it to be better prepared for the future.

Active learning is not without distraction. For instance, Adler and Milne (1997b) suggest a very real struggle for active learning is to convince academics to adopt it. Specifically, the extent to which outcomes of active learning are viewed as real or even attainable ultimately depends on the extent accounting educators can be persuaded of a specific need for a change whose success depends on the adoption of an active learning agenda. Others find assessing the impact of active learning requires an evaluation of its effect within the context of more engaging business related activities such as the inclusion of technology to complete a task (Carter and Jones 2011). Borthick and Jones (2000) support this view and find active learning approaches are effective, especially in environments where new problems are the norm. Hermanson (1994) suggests much work remains to assess active learning, especially in relation to how its adoption will likely improve student reactions in actual business settings. As such, the author contends active learning provides a basis to test for differences in teaching methods whose effects extend beyond the classroom.

Finally, Grabinger and Dunlap (1995) indicate associating active learning with today's fast paced business and academic communities requires a definition of the "learning environment" and an assessment of the use of technology in that environment. However, the authors assert while the promise of active learning may depend on its interaction with technology, the technology in and of itself is not the important catalyst.

Rather, as the authors note, it is how technology is used to promote learning that is the real issue. In brief, the role of technology is to integrate activities so students have the opportunity to work with examples, data, and information to improve learning skills; in essence, technology facilitates the pedagogical goals of the instructor relative to learning (Anderson et al 2007). Indeed, while Edmonds and Edmonds (2008) evaluate the role of the limited presence of technology adoption in active learning and its ability to stimulate greater learning, they suggest the path to identifying an optimal active learning and teaching environment that involves technology is unclear and thus, indicate further experimentation is warranted.

Student Approaches To Learning

Edmonds and Edmonds (2008) observe active learning may promote academic performance. Yet, introducing active learning as a pedagogy, alone, may not produce desired outcomes. Thus, its individual contribution, relative to efforts to reform accounting education, remains a question. Eley (1992) argues the ability of accounting education reform to add benefit is, in part, based on the environment in which pedagogy changes take place. In addition, the author notes a student's approach to learning differs based on the level they are required to share, engage, interact, or otherwise participate in the learning process. Indeed, it has also been found that differences in student performance outcomes depend on how students are asked to carry out assignments and the reaction students have to these assignments (Entwistle and Tait 1990).

Thus, it may be that learning approaches (and their outcomes) require evaluation within the context of student characteristics, the perceptions students might have about learning the task at hand, and an analysis of the outcomes that emerge given student reactions (Sharma 1977; Parsons and Meyer 1990). In general, learning approach refers to the specific form of study activity provoked by a student's perception and reaction to a task, instruction, or occasion and is merely a description of what and how students learn (Entwistle 1991). Evaluating the impact of student learning approaches on performance should observe learning is not simply a function of student held characteristics but in addition, is shaped by an exposure to and the intent of the pedagogy adopted to encourage learning (Lucas 2001).

The deep/surface paradigm focuses on student engagement given the presence of environmentally imposed activities associated with learning. The principle concept of this paradigm is that learning context is important (Parsons and Meyer 1990). As crafted, surface learning is an approach where learning involves adopting actions to merely collect facts to be memorized (Beattie et al. 1997). Under this approach, students do not relate topics to what they already know (Lord and Robertson 2006) and the focus is to attain external outcomes that do not largely affect future performance (Sharma 1997). Finally, surface learning assumes that information is manipulated in a less than uniform manner, with a focus on the outcome of learning being to merely satisfy external assessments (Booth et al. 1999).

In contrast, deep learning is directed towards intentional content (Hand et al. 1996). The premise of deep learning is to understand the meaning of the object of learning where new topics are related to existing knowledge and experience (Lord and Robertson 2006). It sees learning as an internalized function based on relating parts to derive a wider picture for understanding how knowledge fits together and is created (Sharma 1997). Finally, deep learning consists of studying material for its own merit and, then, interpreting materials against personal knowledge, structures, frameworks, and experience (Eley 1992).

Learning Context

Assessing student participation (active learning) and approaches to learning (deep/surface learning) only partially address how a model can be developed to maximize the objective of accounting education change. Such a model also assumes learning context matters. Sharma (1997), for example, asserts context affects both active and deep verses surface learning and calls for accounting education research to examine learning outcomes with an emphasis on context. Lord and Robertson (2006) provide a review of the differential effects of deep verses surface learning when several education reform interventions are considered and find outcomes differ in environments where the responsibility for learning is shared between instructor and student.

Learning context includes the curricula and teaching methods, the atmosphere of the course, the program of study, and the assessment methods that define, measure and evaluate the outcomes of the education production function (Sharma 1997). Frederickson and Pratt (1995) model instructional methods, course content, and curriculum as key attributes that contribute to the creation of education outcomes and suggest these attributes, along with faculty directives and student ability, establish the "environment" or context in which learning takes place.

Evidence suggests the importance of the learning environment relative to learning outcomes. Booth et al. (2008) recognize any response to a call for accounting education reform should include an assessment of how students learn and the context in which learning takes place. Gow et al. (1994) indicate assessing the role of the learning context on student performance is a necessary component for accounting education reform. Potter and Johnston (2006) agree and suggest an environment that encourages active learning improves student outcomes and requests further work to explore the impact changes in teaching strategies have on learning outcomes in a range of other contexts, especially as they relate to the preparation of students for the profession.

Jackling (2005a) evaluates the role an approach to learning and the learning environment has on learning outcomes. Results show sophisticated learning approaches are adopted over time and that elements of the learning environment under the educator's control can be employed to positively influence the way students approach studying. Hall et al (2004) arrive at similar conclusions and suggest strategic changes in the learning environment, over time, increase deep learning, which, in turn, is likely to improve student outcomes. The authors call for additional work to assess the direct impact of learning-context generated deep learning on student grade performance.

Finally, Ballantine et al. (2008) examine changes in the level of deep learning for accounting and business students given a change in pedagogy. Results indicate introducing change encourages more effective learning strategies, especially when the longitudinal effects of time are considered. The authors also note research in this area would benefit from additional studies that look at the differing effects other types of educational interventions have over time.

Technology: Its Role as a Learning Intervention

Albrecht and Sack (2000) observe the rapid infusion of technology is one of the most major developments in business today. The authors also note accounting education has failed to fully embrace technology as a part of its pedagogy. Early on, accounting education reform made mention of embracing technology as part of the accounting learning environment, For example, the American Accounting Association (AAA) recommends the accounting academic community employ some form of computer assisted instruction in its educational environment (AAA 1986). In addition, the AECC, in its Positon Statement One, highlights the need accountants have for technology (AECC 1990).

Togo and McNamee (1995) find the learning benefits associated with including computer (technology) use in a course promotes analytical ability, creative thinking, attention to detail, and integrative analysis. (Anderson et al 2007) agree but offer additional insight about the value of technology relative to teaching. Specifically, they suggest while efforts conducted in the classroom could continue to be effective under the paper/pencil principle, the use of technology facilitates classroom discussions that would otherwise not be possible. Indeed, Du and Wagner (2005) contend advances in technology based knowledge acquisition provides an opportunity to move beyond traditional instruction, enables new modes of learning, and facilitates knowledge construction Finally, the authors suggest research involving the introduction or expansion of a technology intervention as part of the education production function should focus on how it facilities learning.

Observations about technology and its role in accounting education reform do exist. For example, Ahadit (2008) indicates that as technology continues to have a significant role in business, it is important that those making decisions about accounting education reform integrate its use into change agendas to take advantage of the association between technology and learning. Wells et al (2008) indicate a technological intervention promotes flexible learning and actively involves students in the learning process by facilitating deep learning. Thus, it could be that introducing technology based instruction encourages students to take responsibility for their own learning and facilitates the acquisition of skills that promote lifelong learning. Al-Khadsh and Al-Beshtawi (2009) suggest as much as they observe the inclusion of computers (technology) in accounting is central to providing students with the skills they need to gain the experience and attitude to work as professionals after graduating.

Yet, for all this hype, a seminal query remains: how has the intervention of technology directly impacted student performance (Edmonds and Edmonds 2008).We contend technology is a tool that can be used to improve the delivery, content, and outcomes (i.e., student performance) of accounting pedagogy. Our approach to defining technology for use is this paper follows the observations of Ely and Plomp (1986) and Simsek (2005) which craft a definition of technology based on how its use promotes learning1.

Specifically, Ely and Plomp (1986) provide a viable definition of the use technology in an educational setting as one that moves away from the concept of hardware to a focus on learning. Under this approach, the authors observe "[Technology] is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives and employing a combination of human and non-human resources to bring about more effective learning" (p. 233). Simsek (2005) adds additional insight by viewing the education/technology link as "applying scientific information and processes onto the problems of education… [such that one] has a way of looking at instructional problems and examining feasible solutions to those problems" (p. 179).

Given the above, we assert it is not the presence of a physically viewed perspective of technology (hardware) that is important but rather, it is the extent to which technology is viewed as an intangible learning assistance tool that adds value.2 Thus, it is the learning effort and the associated environments that must be kept in focus when evaluating accounting education reforms that involve the adoption of a technological intervention. Under this rubric, then, it is logical to look at technology based pedagogical interventions as those that adapt and promote learning. In doing so, the focus clearly remains on learning and the effects adoption has on learning outcomes.

The reaction or consequences of this broader approach to teaching (an introduction of technology), and hence learning, and how it relies on the introduction and use of technology to improve student outcomes can be thought of as a technology based pedagogy (i.e., hence our use of TBP). Under this prescription, and in accordance with the Frederickson and Pratt (1995) framework, technology can be thought of as a teaching or curriculum intervention that operates as an additional instructional tool added to the education production function. Anticipated outcomes of introduction are improved student learning and hence, improved student performance.

Constructing accounting education reform using this view of an technological intervention (i.e., our TBP) works to yield an assessment of the interactions between computer based learning (i.e., the use of technology in accounting

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[1]The work of Ely and Plomp (1986) and Simsek (2005) actually focus on the perceptions accorded the term educational technology over time. Note, while we use the definition of educational technology to initially establish the context in which we define a TBP, our intent is to provide a more informative view of the objective of our study.
[2] Part of our capacity to assess technology in this manner is based on perspectives we draw from Orlinkowski (1992). Specifically, the author provides perspectives of technology that move away from a "hardware" view which suggests technology is meaningful only when one thinks of it relative to an organization that employs machinery in their productive activities. Instead, alternative views offered by the author describe technology as an independent influence that exerts some unidirectional, causal influence on humans. As such, technology is a product of ongoing human action. The role of technology, then, depends on human actors and its effect is moderated by other contextual variables. Therefore, under this view, the specific organizational context and the actions of knowledgeable, reflexive humans must be considered.

pedagogy), instructor control, individual student attributes, and other environmental factors mentioned by others (Bryant and Hunton 2000). In addition, it helps bring clarity to the use of technology as a pedagogical intervention (i.e., our TBP) and thus, allows for a more direct link between the intervention, student involvement as a result that intervention, and the effect, if any, on student outcomes.

Moreover, as Rebele et al (1998) indicate, when conducting accounting education research in the technology area, the focus should be on whether and to what extent the application of technology leads to effective learning. The authors call for more research to explore how the use of technology can continue to evolve and improve accounting education. Thus when all is considered, it is our view that a valid approach to accomplish the objective of our study is to adopt our TBP perspective and assess its differential effects on performance across learning contexts over time.

The Setting

The purpose of this study is to determine the predictive power of TBP relative to student performance in Financial I and to assess how information obtained might be used as input to guide accounting education reform. The premise of our inquiry, following insight from Bryant and Hunton (2000) and Rebele et al (1998), is that technology is an additional tool used to construct and deliver effective accounting pedagogy. It is not the presence of technology (i.e., the simple use of a computer in class) but rather, the intervention of a focused adoption of technology within the context of how it affects the learning environment and how it interacts with other components of the education production and finally, how all variables work together to enhance student learning and, ultimately, performance, that is our query. We posit the link between TBP and performance outcome is based on the extent to which a TBP stimulates self-directed learning, as well as critical thinking and analytical skills.

Following previous work, we assess the effect of our pedagogical intervention (i.e., TBP) in the presence of other demographic and environmental variables known to affect performance (Bryne and Flood 2008; Eikner and Montondon 2001; Frakes,1997; Turner et al. 1997); Didia and Hasnat 1998). In doing so, we align with the Frederickson and Pratt (1995) education production function where curriculum content, course content, instructional methods, student ability and effort, and faculty ability and effort are considered factors associated with student performance. However, in our study we apply the TBP/learning context/student learning nexus to investigate the extent to which previous performance outcomes associate with subsequent ones. Our intent is to assess the extent to which the presence of an intervention that requires more active and focused learning affects performance over time.

One last additional observation set warrants attention. As our focus is to assess the impact of TBP on performance, we concern ourselves with the adoption of a pedagogy that depends on the use of technology, rather than the mere presence of that technology, as the catalyst for change. We have used input from the literature to support the adoption of such an approach. We have also clearly made the case, again through our extensive use of the existing literature, that a possible link exists between computer based learning (i.e., our TBP) and student performance. We have also used theory to draw inferences that TBP promotes active and deep learning and that the outcome of both should be improved outcomes. As such, our focus is to evaluate these observations when TBP is present. Finally, we make no attempt to actually measure the level of active or deep learning, either in change or in total. Rather, our objective is to evaluate whether differential outcomes emerge given the adoption of a TBP that is associated with active and deep learning.

We conduct our investigation in Financial I based on the importance this course has in the accounting curriculum and the impact performance in this course has on future performance in other more advanced accounting courses. Indeed, English et al. (2004) observe that Financial I is a core course designed to ensure accounting students will have the essential foundation required of subsequent courses. We note two additional observations to support our choice. First, we follow others who have used Financial I to assess the effects of a pedagogical intervention (Davidson 2002; Bryne and Flood 2008: Hall et al. 2004: English et al. 2004). Second, as indicated in Position Statement Two of the AECC , the primary objective of the first course in accounting is to facilitate learning (AECC 1992). As the report further notes, student involvement in Financial I should be encouraged and facilitated by methods that require student input so they are taught how to learn on their own and gain life-long learning skills.

Given these observations, we argue our decision to conduct our study using Financial I can be regarded as appropriate.

Methodology

The subjects and procedures used in this study are described below.

Subjects

Subjects consisted of 182 students enrolled in Financial I at a large university in the Midwest. In order to eliminate bias caused by teaching styles, all students participating in the study were taught by the same instructor (Bernardi and Bean, 1999). Students were not compensated to participate, but nevertheless, all 182 (100 percent) enrolled students participated.

Experimental Design

The purpose of this study is to determine the predictive power of TBP relative to student performance in Financial I and to assess how the information obtained might be used as input to guide accounting education reform. To do so, we identified sections of Financial I that were taught by the same instructor and had the same syllabus. These steps contribute to the best possible comparison between the two groups.

The students in the sections were placed in two groups. The first group (i.e., the Control Group), followed the traditional pedagogy delivery format where in-class lectures were provided and problems were solved during class. The second group, (i.e., the Test Group), was introduced to TBP. Specifically, students in the Test Group where required to use an online based instruction platform. This platform included mechanized materials that introduced subject materials to students. The Test group was required to gain access and review these materials prior to coming to class. In addition, these students were instructed to attempt problem sets. When Test Group students came to class, the instructor provided some lecture but mainly relied on the pre-preparation activities required of students outside of class to guide classroom content. There were 118 students in the Control group and 64 in the Test group. Finally, neither group was aware of the study being undertaken.

Variable Definition

In this study, while delivery methods differed student performance was measured the same for both groups. Specifically, during the course three unit exams were administered. Both groups were evaluated using the same exam. The exams are referred to Exam 1*(E1)*; Exam 2 *(E2)*; and Exam 3 *(E3)*. The scores reflected on *E1, E2* and *E3* were the percentage of correct answers relative to a 100% base. In addition, we also measured performance based on the difference in exam results posted between two consecutive exams of the course to isolate changes in performance over time. Under this rubric, the difference between *E2* and *E1* is referred to as *EC1* and the difference between *E3* and *E2* is referred to as *EC2*. We also sought to isolate performance of the entire spread of the course. This is the difference between *E3* and *E1* is referred to as *EC3*.

The goal of our study is to assess the impact of TBP on performance over time. Our Test Group is associated with TBP; our Control group is not. Under this design the dichotomous variable TECH was used as a proxy for the presence of TBP with a value of 1 (for the Test Group) and a value of 0 otherwise (for the Control Group). We also sought to associate the effects of the presence of TBP on exam performance over time by creating the following interaction terms: TECH1 is the interaction of TECH*EC1 which reflects the product of TBP exposure and the performance difference between Exam 2 and Exam 1 performance; TECH 2 is the interaction of TECH*EC2 and reflects the product of TBP and the performance difference between Exam 3 and Exam 2 performance.

Finally, prior literature suggests investigating any intervention variable associated academic performance requires one to identify and include student held attributes variables as these could have an impact on performance (Bryne and Flood 2008). Variables chosen for inclusion in this study to isolate such an effect are gender (GENDER) (Eikner and Montondon 2001); age (AGE) (Frakes,1997); cumulative grade-point (CUMGPA) (Turner et al. 1997); the course load taken during the semester under review (LOAD) (Didia and Hasnat 1998); and race (RACE) (Bryne and Flood 2008).

Univariate Testing

Isolating the differential effects of TBP on performance over time is our study query. An initial approach to assessing the predictive ability of TBP is to evaluate results for both the Test and Control groups on a within and between basis. To do so, we conduct within analyses to compare E2 vs E1; E3 vs E2; and E3 vs E1 for both the Test and Control. We also conduct between analysis where we compare EC1 (Control vs Test); EC2 (Control vs Test); and EC3 (Control vs Test). We adopt two-sample t-tests to empirically evaluate these comparisons.

Multiple Regression Testing

A component of our study is to assess the predictive value of TBP on performance over time. In doing so, we attempt to capture the differing effects associated with adopting a learning context that includes an additional pedagogical tool designed to actively engage students and promote deeper learning skills over time. As such, our variable of interest is the overall change in performance throughout the course (EC3).

Our inquiry takes two steps. First, we assess the impact of prior performance and control variables on our dependent variable for both the Test and Control groups following the ordinary least squared (OLS) regression model:3

$$EC3 = \beta + \beta_1 E1 + \beta_2 E2 + \beta_3 CUMGPA + \beta_4 AGE + \beta_5 LOAD + \beta_6 GENDER + \beta_7 RACE + \varepsilon \quad [1]$$

where:

EC3	=	The difference in exam results posted between the third exam of the course and the first exam of the course.
E1	=	The grade (percentage of correct answers) posted for exam 1
E2	=	The grade (percentage of correct answers) posted for exam 1
CUMGPA	=	Cumulative grade point average at the start of the semester in which Intermediate I was taken (4.0 basis).
AGE	=	Age of student.
LOAD	=	Current semester course load.
GENDER	=	Dichotomous variable equal to 1 if student is male and 0 otherwise.
RACE	=	Dichotomous variable equal to 1 African American and 0 otherwise.

Second, we introduce TBP and assess its longitudinal impact on performance. Accordingly, we examine the impact of the presence of TBP and its interaction with performance throughout the course. Under this approach, the Test and Control groups have been combined to assess the full effect of TBP and its interactions. Under this model, and in following the approach adopted by Monem (2007) we dis-aggregate the time effects of TBP between short term and long term. We also make attempts to further isolate the impact that prior performance and learning (E1, E2, and CUMGPA) in a specific learning context have on overall performance. In doing so, we look at changes within the semester that could be associated with enhanced learning prompted by the infusion of TBP. This, in our view, helps to reveal the causality relationship between the inclusion of TBP and the resulting deep learning and the impact that

[3] Our modeling follows Monem (2007) who posit prior academic performance in a course represents a specific skill that could affect long term performance. As such, we include these outcomes (i.e., *E1, E2*) as well *CUMGPA* to better assess and isolate the effect TBP may have on long term performance.

they, collectively, have on performance over time. Finally, we also include control variables in the following ordinary least squared (OLS) model:

$$EC3 = \beta + \beta_1 E1 + \beta_2 E2 + \beta_3 CUMGPA + \beta_4 AGE + \beta_5 LOAD + \beta_6 GENDER + \beta_7 RACE$$
$$+ \beta_8 TECH + \beta_9 TECH1 + \beta_{10} TECH2 + \varepsilon \qquad [2]$$

where:

EC3	=	The difference in exam results posted between the third exam of the course and the first exam of the course.
E1	=	The grade (percentage of correct answers) posted for exam 1
E2	=	The grade (percentage of correct answers) posted for exam 1
CUMGPA	=	Cumulative grade point average at the start of the semester in which Intermediate I was taken (4.0 basis).
AGE	=	Age of student.
LOAD	=	Current semester course load.
GENDER	=	Dichotomous variable equal to 1 if student is male and 0 otherwise.
RACE	=	Dichotomous variable equal to 1 African American and 0 otherwise.
TECH	=	Dichotomous variable equal to 1 if student was exposed to TBP and 0 otherwise
TECH1	=	Reflects the product of TBP exposure and the performance difference between exam 2 and exam 1 (TECH*[Exam 2 performance – Exam 1 Performance]).
TECH2	=	Reflects the product of TBP exposure and the performance difference between exam 3 and exam 2 (TECH*[Exam 3 performance – Exam 2 Performance]).

Empirical Tests Results

Descriptive

Panel A, B, C of Table 1 present the descriptive statistics for the full, control, and test samples. TECH, TECH1, and TECH2 are present for the full group only. Relative to performance, the full sample reflected a mean of (0.6985) for E1, (0.6516) for E2, and (0.6403) for E3; the highest performance posted was on E1. The Control group follows a similar pattern with mean performances of (0.7081), (0.6665), and (0.6292) for E1, E2, and E3 respectively. However for the Test group, while E1, at (0.6808), reflects the highest average performance for that group, E3, at (0.6609), comes in second. In essence, this third exam performance reflects a rebound from the second exam average performance of (0.6240).

Changes in performance between tests can be highlighted. As captured in single test performance, for the full model, both performances between exam 3 and exam 2 (EC2) and exam 3 and exam 1 (EC3) decreased. This pattern was also reflected for the Control group. However, for the Test group, the EC2 performance is positive while EC3 is negative; moreover the decrease in EC3 is less than that of Control

In Table 2, we present the correlation coefficients between all independent variables in the regressions for the full sample (the correlation coefficients for the un-tabulated reduced samples are similar). This is provided as several independent variables are incorporated in a regression model and as such, the statistical inference on the variables could be affected by multicollinearity. Multicollinearity is a high degree of correlation (linear dependency) among several independent variables. It commonly occurs when some of the independent variables measure the same concepts or phenomena. Results suggest multicollinearity is not a major issue in our tests.

Univariate Two Sample T-Tests

The results from the two-sample tests are reported in Tables 3 and 4. Panel A and B of Table 3 present within-sample tests for the Control and Test groups, respectively. As depicted in Panel A of Table 3, the mean performances of E2 and E1 are significantly different (at the 0.0001 level) with E1 performance being higher (0.7081 verses 0.6665); the mean difference is (-0.0416). Interpretations of these result indicate performance is better on the first test. Moving forward, comparing the mean performances on E3 and E2 indicates the spread between the second and the third test (-0.0373) was also significantly different (at the 0.005 level). Again, as with the first spread, performance on the latter exam or E3 is significantly lower. Finally, when comparing performance over the entire course, we find that E3 and E1 means for the Control group are significantly different (at the 0.0001 level). Specifically, with a numerical posted difference of (-0.0789), the latter exam performance is lower.

Interpreting these result lead to an observation that for Control, the best performance was on E1, or the initial examination. Further, an unbroken downward trend occurred such that E1 was higher than E2, and E2 was higher than E3. In addition, the difference between E1 and E2 performance (-0.0416) is essentially the same as the difference between E3 and E2. However, the difference between E3 and E1 (-0.0789) is almost twice that of the other differences.

Overall, within analysis of Control group performance suggests that performance peaked at the beginning. Specially, no increase in performance across time is noted. In addition, the differences in examination performance across time between any two successive exams indicate that performance did not increase. Inferences could be drawn that the examination experiences of the Control group do not appear to suggest insight was gained over time. At least, not from the perspective of examination results.

Panel B of Table 3 reports the results for the Test group. As depicted, the mean performances on E2 and E1 are significantly different (at the 0.0001 level) with E1 performance of (0.6808) being higher than that of the mean of (0.6240) the Test group posted for E2. The spread between the examinations was (-0.0568). Sequentially, the mean performances on E3 and E2 are also significantly different (at the 0.05 level). Yet, the Test group improved performance between E3 and E2. Specifically, the group posted a (0.0369) increase or positive improvement between the second and last exam. Finally, for the Test group, there is no significant difference in the mean performances on E3 and E1.In other words, the mean performance comparison of (0.6808) for E1 and the (0.6609) for E3 (or a mean difference of (-0.0199) was not significant.

Additional analysis also indicates that while the Test group's performance on E1 was its highest, and while there was a drop in performance between E1 and E2, the group rebounded such that while the performance of E1 still remained the highest, performance on E3 exceeded that of E2. Finally, while there was a numerical difference between E3 and E1 in favor of E1, the numerical difference was not statistically significant. The inference here is that some sense of learning affecting the behavior and hence, performance of the Test group has occurred. Insight from this within analysis of the examination performance suggests that the Test group performance beyond E1 stayed the same or improved when viewed from a statistical perspective.

Table 4 provides the between two-sample test results. Analysis 1 indicates no significant difference in the mean changes in performance on E2 and E1 (i.e., EC1) between Control and Test. In addition, the magnitude of spread for Control (-0.0416) is less than that of Test (-0.0568). However, comparisons of subsequent means performances over time yield different between analysis results. Specifically, Analysis 2 shows that at EC2 (i.e., E3 verses E2), there is a significant difference in the mean changes (at the 0.0001 level). Specifically, the change between E3 and E2 for Control is (–0.0373), which is a reduction, while the mean change for Test for the same spread is a gain of (0.0369). These results, when taken in tandem with the within results reflected in Table 3, suggest that the results of the performance of the Test group is strong when compared to itself on a historical basis, and to the Control group concurrently.

Finally, Analysis 3 shows that at EC3 (E3 verses E1), there is a significant difference in mean response changes (at the 0.05 level). Again, as with EC2, over time the Test group performed better than the Control group. Specifically, while both Test and Control posted reductions in average performance for EC3, the reduction was smaller for Test relative to Control (i.e., -0.0199 verses -0.0789). Interpretatively, with an exhibition of at least maintaining level and change performances over time, one might assume that there might be some element present in the Test group environment that is differentially driving a difference in performance over time.

Multiple Regression

The only differing component between the Test and Control group is the adoption of TBP, which in our models are proxied for by TECH. The purpose of this study is to assess the extent to which a TBP intervention contributes to student performance. Tables 3 and 4 provide univariate empirical evidence of at least the maintenance of Test group performance over time. The contrary holds true for the Control group. Specifically, both within and between analysis suggest Control performance decreases over time. We now report the results of the application of our multiple regression models to assess whether the results we obtained via univariate testing will hold. We do so by including our TBP intervention in a direct fashion via OLS regression. Our measure of interest we assert is affected by this intervention is EC3, which in our models proxy for long term performance.

Accordingly, in this section we first report the results from the OLS regression model for both Control and Test. In this model, we include E1, E2, along with CUMGPA, AGE, LOAD, GENDER, and RACE variables in the OLS regression models (equations [1]). In essence, this test examines a long term performance absent the specific isolation of TBP (i.e., the inclusion of TECH and its interactions).

The results are reported in Table 5 for both Control and Test. As captured, E1 and E2 are significant to a change in long term course performance for both Control and Test in the absence of TECH, our proxy for TBP. This outcome is supported by evidence provided by Monem (2007) that past performance in a course captures some specific ability as related to future performance. Thus, E1 and E2 act as additional control variables on our attempt to assess the effect of TECH on student performance over time. For Test, E1 and E2 are negative (significant at the (0.0001) and positive (significant at the 0.05 level), respectively. Other variables found to be significant for the Test group are CUMGPA (positive and significant at the 0.05 level) and AGE (negative and significant at the 0.005 level).

Control posts similar results. As expected, E1and E2 affect long term performance in a fashion similar to Test; specifically E1 is negative and significant at the 0.0001 while E2 is positive is significant at the 0.005 level. Finally, the adjusted R2 for Test (0.41) is higher than that of Control (0.23). These results suggest the explanatory power of the Test model exceeds that of Control.

The goal of our study is to assess the impact a TBP intervention has on performance over time. Table 6 presents the full sample of the OLS regression model when the Control and Test groups are combined (equation [2]). Thus, this test examines long term performance when TBP is present, as proxied by the inclusion of TECH and its interactions. Five models are presented.

Model 1 reports the initial full sample. Results indicate E1, E2, and CUMGPA are significant to long term predictability (at the 0.0001; 0.0001; and 0.005 levels) respectively. In addition, note the value of E1 is negative while E2 and CUMGPA are positive. Finally, the adjusted R2 is (0.27). These results mirror the results presented in Table 5 for both the Test and Control groups.

Model 2 reports an initial observation of the effects of TBP via our introduction of TECH. Results show that similar to Model 1 as well as the results presented in Table 5, E1, E2 and CUMGPA retain their effects in the presence of TECH. In addition, TECH is positive and significant (at the 0.05 level), thus indicating the presence of TBP differentially affects long term performance. Moreover, with an adjusted R2 of (0.29), evidence emerges to suggest the predictive ability of our model improves when TECH is introduced.

Model 3 extends Model 2 by including TECH1. As shown, E1, E2, CUMGPA, and TECH maintain relevance and have signs consistent with pass results. However, while TECH is significant TECH1 is not. Initial observations of these results suggest TECH, while relevant to long term performance, in the short term that effect may not appear when combined with results that represent the impact of effects of initial feedback in tandem with learning (i.e., TECH1). In other words, the effect of TECH may not have fully been fully appreciated at this juncture. Notwithstanding, the predictive capability of Model 3 where adjusted R2 is (0.30) exceeds that of both Models 1 and 2.

Model 4 also extends Model 2 by including TECH2 while removing TECH1. Here, the trend continues such that E1, E2, and TECH remain significant and maintain their signs. However, CUMGPA is no longer significant. TECH2 is significant (at the 0.0001 level). Inference can be made that with the inclusion of TECH2, the ability of CUMGPA to predict long term performance diminishes. This effect may relate to the power that a TBP/prior learning combination has on long term performance as this combination could promote more active and deep learning. This appears to support our results found in Model 3 which find TECH1 not significant to long term performance while TECH has relevance. An additional observation of this is that TECH is significant at this juncture, suggesting that the presence of a TBP intervention has predictive capacity. Finally, under Model 4 we see a continued trend of an increase in adjusted R2 as the predictive power of Model 4 is (0.47).

Finally, Model 5 reports the results of our completed analysis that includes all of the interactions to assess their effect on performance over time. When examined, we find as with prior outcomes, E1, E2, and TECH are significant and maintain their signs. Relative to the impact of TECH and its interactions, we find that TECH1 and TECH2 are both significant (at the 0.005 and 0.0001 levels, respectively). This allows inference that TBP has a positive effect on performance over time. In addition, based on these results we can infer that when TECH and its interactions are evaluated in tandem relative to overall performance, we find that a TBP intervention significantly impacts performance across time. This evidence supports results obtained in Model 4 that the efficacy of a TBP appears when long term performance is evaluated in the presence of how it impacts all performance. In doing so, the entire effects of a TBP intervention are captured. Finally we note that in the all-inclusive model, at (0.50), the value of R2 is at its largest. This suggest two considerations. First as models are developed to increase the presence of a TBP, the information about the effect of the TBP emerges. Second, more evidence emerges about use of a TBP to affect change surfaces.

Implications for Accounting Education Reform

The purpose of this study is to assess the extent technology based pedagogy (TBP) contributes to student performance and how information obtained about this linkage can be employed to guide accounting education reform. Our results indicate that a TBP has an impact on student performance across time. We also demonstrate that it is best to evaluate an intervention, over time, via a multi-level discrete period process as single level analyses may yield conflicting, mis-informed, or incomplete results.

We do, however, understand our results should be placed within a framework that recognizes limitations may exist with any empirical investigation. Our results are based on the use of students from one institution. Thus, it could be students at this institution hold some specific affection for the type of pedagogical intervention adopted. Or it could be the type of intervention we introduce might have been exposed to the students in a course taken prior to Financial I, and that this exposure heightened an ability to conform to such an intervention. While efforts were taken to mitigate these differential effects they could, nevertheless, persist. As such, the generalizability of our study has limits.

In addition, our study focuses on the link between actual performance in the presence of an intervention. The intervention we chose (TBP) is one that includes elements that have been described as having the capacity to promote active engagement and deep learning. Accordingly, our setting seeks to evaluate the role an intervention thought to enhance the extent students engage and learn have on performance. Our focus was then to test for and evaluate for such an outcome (enhanced performance). However, our methodology did not include developing or using a measure of the numerical extent to which active or deep learning has occurred. Admittedly, such an approach has merit and could be the basis of future research. As such, we note this as a limitation of our study.

Nevertheless, even with these limitations we can advance how our study could work to further the movement to adopt a credible and value adding framework to focus on accounting education reform. First, we find that a TBP intervention has value. The merit of this finding, however, is that we identify a link based on how students are taught, how they learn, and how they process what they have learned to improve future performance via the introduction of a pedagogical intervention that has these objectives as a base. We conduct our investigation in Financial I, the course often thought as most important relative teaching future accounting students how to learn. Finally we assess the impact of a TBP intervention takes time and that its effects should be evaluated holistically.

The implication we offer to guide the adoption of accounting reform rest on these observations. First, at an institution it may be a good idea to initially introduce reform at the introductory level of accounting education. In doing so, the idea of learning to learn is embedded early. Second, reform should be implemented in a long term fashion such that the impacts of prior reforms are linked to those identified for the future. This is especially notable when we consider how the effects of our TBP intervention were not fully realized until the end and that the final outcomes depended on those preceding it. As such, it may be that reforms need to be implemented across time and even courses.

Finally, it may be that the key to effective reform is the student. Indeed, our focus here was to develop a response to calls for reforms using an intervention based on how students react to and process learning in reaction to a pedagogical intervention that relied on its ability to spur active engagement and deep mental processing. It could be that reform has missed its mark in that it has lost sight of student inclusion. As such, future reform efforts might benefit by returning to a focus on the student.

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Table 1
Descriptive Table 1
Descriptive Statistics

Variable	N	Mean	Std Dev	Minimum	Maximum
Panel A: Full Sample					
E1	182	0.6985	0.1328	0.3500	0.9750
E2	182	0.6516	0.1394	0.2750	0.9750
E3	182	0.6403	0.1397	0.1750	0.9150
EC2	182	-0.0112	0.1380	-0.3600	0.4000
EC3	182	-0.0582	0.1311	-0.3500	0.2750
CUMGPA	182	2.6528	0.8542	0.0800	4.0000
AGE	182	20.8461	1.8141	19.0000	32.0000
LOAD	182	13.9065	3.3069	3.0000	24.0000
GENDER	182	0.5824	0.4945	0.0000	1.0000
RACE	182	0.2802	0.4503	0.0000	1.0000
TECH	182	0.3516	0.4788	0.0000	1.0000
TECH1	182	-0.0199	0.0792	-0.3000	0.22500
TECH2	182	0.0129	0.0862	-0.2750	0.40000
Panel B: Control Group					
E1	118	0.7081	0.1307	0.4500	0.9600
E2	118	0.6665	0.1296	0.4050	0.9750
E3	118	0.6292	0.1407	0.3150	0.9150
EC2	118	-0.0373	0.1284	-0.3600	0.3000
EC3	118	-0.0789	0.1298	-0.3450	0.2550
CUMGPA	118	2.5761	0.8498	0.7500	4.0000
AGE	118	20.8474	1.9019	19.0000	32.0000
LOAD	118	13.5932	3.7649	3.0000	24.0000
GENDER	118	0.5932	0.4933	0.0000	1.0000
RACE	118	0.3050	0.4624	0.0000	1.0000
Panel C: Test Group					
E1	64	0.6808	0.1360	0.3500	0.97500
E2	64	0.6240	0.1530	0.27500	0.9000
E3	64	0.6609	0.1365	0.1750	0.9000
EC2	64	0.0369	0.1430	-0.2750	0.4000
EC3	64	-0.0199	0.1255	-0.3500	0.2750
CUMGPA	64	2.7940	0.8508	0.0800	4.0000
AGE	64	20.8437	1.6544	19.0000	27.0000
LOAD	64	14.4843	2.1380	9.0000	21.0000
GENDER	64	0.5625	0.5000	0.0000	1.0000
RACE	64	0.2343	0.4269	0.0000	1.0000

Table 1 (continued)
Descriptive Table 1
Descriptive Statistics

This reports the descriptive statistics for the key study variables. EC3 = the difference in exam results posted between the third Exam of the course (E3) and the first exam of the course (E1); EC1 = the difference in exam results posted between the second Exam of the course (E2) and the first exam of the course (E1); (E1) = The grade (percentage of correct answers) posted for Exam 1; E2 = The grade (percentage of correct answers) posted for Exam 2; CUMGPA = Cumulative grade point average at the start of the semester in which this Introductory Accounting was taken (4.0 basis); AGE = Age of student; LOAD = Current semester course load; GENDER = Dichotomous variable equals 1 if student is a male and 0 otherwise; RACE = Dichotomous variable equals 1 if African American and 0 otherwise; TECH = Dichotomous variable equals 1 if student was exposed to technology (for Test group) and 0 (for Control group) otherwise. TECH1 = Reflects the product of the Technology exposure and the performance difference between Exam 2 and Exam 1 Performance (TECH * [Exam 2 performance – Exam 1 performance] = TECH*EC1); TECH2 = Reflects the product of Technology exposure and the performance difference between Exam 3 and Exam 2 Performance (TECH * [Exam 3 performance – Exam 2 performance] = TECH*EC2).

Statistics

Table 2
Pearson Correlation Analysis
N= 182

	E1	E2	E3	EC1	EC2	EC3	CUMGPA	AGE	LOAD	GENDER	RACE	TECH	TECH1	TECH2
E1	1	0.64*	0.53*	-0.37*	-0.11	-0.44	0.55*	0.19***	-0.12	0.11	-0.36*	-0.1	-0.15**	-0.09
E2		1	0.51*	0.46*	-0.49*	-0.11*	0.52*	0.27**	-0.07	0.07	-0.23**	-0.15***	0.38	-0.4
E3			1	0	0.49*	0.52*	0.51*	0.01	0.02	0.05	-0.18***	0.11	-0.03	0.25**
EC1				1	-0.47*	0.37*	0	0.11	0.06	-0.05	0.14	-0.06	0.63*	-0.38*
EC2					1	0.64*	-0.01	-0.25**	0.09	-0.02	0.05	0.26**	-0.42*	0.65*
EC3						1	-0.01	-0.17***	0.15**	-0.06	0.17***	0.21	0.11	0.36
CUMGPA							1	-0.01	0.15***	-0.04	-0.25**	0.12	0.04	0.02
AGE								1	-0.26**	0.11	-0.11	0	0.05	-0.23**
LOAD									1	-0.04	0.01	0.13	0.03	-0.05
GENDER										1	-0.09	-0.03	-0.08	-0.01
RACE											1	-0.08	0.17***	-0.06
TECH												1	-0.30*	0.20**
TECH1													1	-0.60*
TECH2														1

This reports the correlation analysis for the key study variables. Spearman Rank correlation analysis (un-tabulated) provides similar results. EC3 = the difference in exam results posted between the third Exam of the course (E3) and the first exam of the course (E1); E1 = The grade (percentage of correct answers) posted for Exam 1; E2 = The grade (percentage of correct answers) posted for Exam 2; CUMGPA = Cumulative grade point average at the start of the semester in which this Introductory Accounting was taken (4.0 basis); AGE = Age of student; LOAD = Current semester course load; GENDER = Dichotomous variable equals 1 if student is a male and 0 otherwise; RACE = Dichotomous variable equals 1 if African American and 0 otherwise; TECH = Dichotomous variable equals 1 if student was exposed to technology (for Test group) and 0 (for Control group) otherwise. TECH1 = Reflects the product of the Technology exposure and the performance difference between Exam 2 and Exam 1 Performance (TECH * [Exam 2 performance – Exam 1 performance] = TECH*EC1); TECH2 = Reflects the product of Technology exposure and the performance difference between Exam 3 and Exam 2 Performance (TECH * [Exam 3 performance – Exam 2 performance] = TECH*EC2). *, ** and *** denote statistical significance at the o.0001, 0.oo5 and 0.05 levels for two tailed tests.

Table 3
Within T-Test
Single Test Performance

	E2	E1	t-stat on diff	E3	E2	t-stat on diff	E3	E1	t-stat on diff
Panel A: Control Group Performance (N=118)									
	0.6665	0.7081							
	(0.13)	(0.13)	4.19 *						
				0.6292	0.6665				
				(0.14)	(0.13)	3.06 **			
							0.6292	0.7081	
							(0.14)	(0.13)	-6.60*
Panel B: Test Group Performance (N=64)									
	0.6240	0.6808							
	(0.15)	(0.14)	3.61 *						
				0.6609	0.6240				
				(0.14)	(0.13)				
						-2.06***			
							0.6609	0.6808	
							(0.14)	(0.14)	-1.27

This reports the descriptive statistics for the key study variables. EC3 = the difference in exam results posted between the third Exam of the course (E3) and the first exam of the course (E1); E1 = The grade (percentage of correct answers) posted for Exam 1; E2 = The grade (percentage of correct answers) posted for Exam 2; CUMGPA = Cumulative grade point average at the start of the semester in which this Introductory Accounting was taken (4.0 basis); AGE = Age of student; LOAD = Current semester course load; GENDER = Dichotomous variable equals 1 if student is a male and 0 otherwise; RACE = Dichotomous variable equals 1 if African American and 0 otherwise; TECH = Dichotomous variable equals 1 if student was exposed to technology (for Test group) and 0 (for Control group) otherwise. TECH1 = Reflects the product of the Technology exposure and the performance difference between Exam 2 and Exam 1 Performance (TECH * [Exam 2 performance – Exam 1 performance] = TECH*EC1); TECH2 = Reflects the product of Technology exposure and the performance difference between Exam 3 and Exam 2 Performance (TECH * [Exam 3 performance – Exam 2 performance] = TECH*EC2).*, ** and *** are significance levels for 0.0001, 0.005 and 0.05 for two sided tests.

Table 4
Between T-Test
Single Test Performance

Analysis 1		**Analysis 2**		**Analysis 3**		**T-Test Results**		
		Control	Test	Control	Test	t-stat	t-stat	t-stat
Control EC1	Test EC1	EC2	EC2	EC3	EC3	EC1vsEC1	EC2vsEC2	EC3vsEC3
-0.0416 (0.11)	-0.0568 (0.13)					1.36		
		-0.0373 (0.12)	0.0369 (0.14)				-3.58*	
				-0.0789 (0.13)	-0.0199 (0.13)			-2.96***

This reports the descriptive statistics for the key study variables. EC3 = the difference in exam results posted between the third Exam of the course (E3) and the first exam of the course (E1); E1 = The grade (percentage of correct answers) posted for Exam 1; E2 = The grade (percentage of correct answers) posted for Exam 2; CUMGPA = Cumulative grade point average at the start of the semester in which this Introductory Accounting was taken (4.0 basis); AGE = Age of student; LOAD = Current semester course load; GENDER = Dichotomous variable equals 1 if student is a male and 0 otherwise; RACE = Dichotomous variable equals 1 if African American and 0 otherwise; TECH = Dichotomous variable equals 1 if student was exposed to technology (for Test group) and 0 (for Control group) otherwise. TECH1 = Reflects the product of the Technology exposure and the performance difference between Exam 2 and Exam 1 Performance (TECH * [Exam 2 performance – Exam 1 performance] = TECH*EC1); TECH2 = Reflects the product of Technology exposure and the performance difference between Exam 3 and Exam 2 Performance (TECH * [Exam 3 performance – Exam 2 performance] = TECH*EC2).*, ** and *** are significance levels for 0.0001, 0.005 and 0.05 for two sided tests.

Table 5
Ordinary Least Squares Regression Estimates of Models 1 – 5 on Full Sample
Model: $EC3 = \alpha + \beta_1 E1 + \beta 2E2 + \beta_3 CUMGPA + \beta_4 AGE + \beta_5 LOAD + \beta_6 GENDER + \beta_7 RACE$

Independent Variables	Test	Control
Intercept	0.7828	0.0719
	(3.79)**	(0.48)
E1	-0.7188	-0.6485
	(-5.14)*	(-5.39)*
E2	0.2079	0.3766
	(1.72)***	(3.28)**
CUMGPA	0.0503	0.0115
	(2.47)***	(0.69)
AGE	-0.0217	-0.0015
	(-2.59)**	(-0.26)
LOAD	-0.0086	0.0032
	(-1.42)	(1.07)
GENDER	0.0004	0.0099
	(0.02)	(0.46)
RACE	-0.0248	0.0327
	(-0.71)	(1.35)
N	64	118
Adjusted R-Squares	0.41	0.23

This table reports the results of regressing the change in performance over the duration of the course on a series of independent variables. Standard errors are in parenthesis. *, **, and *** denote statistical significance at the 0.0001, 0.005 and 0.05 levels for a two tailed test. EC3 = the difference in exam results posted between the third Exam of the course (E3) and the first exam of the course (E1); E1 = The grade (percentage of correct answers) posted for Exam 1; E2 = The grade (percentage of correct answers) posted for Exam 2; CUMGPA = Cumulative grade point average at the start of the semester in which this Introductory Accounting was taken (4.0 basis); AGE = Age of student; LOAD = Current semester course load; GENDER = Dichotomous variable equals 1 if student is a male and 0 otherwise; RACE = Dichotomous variable equals 1 if African American and 0 otherwise; TECH = Dichotomous variable equals 1 if student was exposed to technology (for Test group) and 0 (for Control group) otherwise. TECH1 = Reflects the product of the Technology exposure and the performance difference between Exam 2 and Exam 1 Performance (TECH * [Exam 2 performance – Exam 1 performance] = TECH*EC1); TECH2 = Reflects the product of Technology exposure and the performance difference between Exam 3 and Exam 2 Performance (TECH * [Exam 3 performance – Exam 2 performance] = TECH*EC2).

Table 6
Ordinary Least Squares Regression Estimates of Models 1 – 5 on Full Sample
Model: $EC3 = \alpha + \beta_1 E1 + \beta 2E2 + \beta_3 CUMGPA + \beta_4 AGE + \beta_5 LOAD + \beta_6 GENDER + \beta_7 RACE + \beta_8 TECH + \beta_9 TECH1 + \beta_{10} TECH2 + \epsilon$

Independent Variables	Model 1	Model 2	Model3	Model 4	Model 5
Intercept	0.3159 (2.59)***	0.3098 (2.58)**	0.3057 (2.54)***	0.0650 (0.60)	0.0252 (0.24)
E1	-0.7042 (-7.69)*	-0.6799 (-7.51)*	-0.7438 (-6.95)*	-0.7508 (-9.53)*	-0.6009 (-6.52)*
E2	0.2360 (2.84)**	0.2768 (3.32)**	0.3471 (3.32)**	0.5502 (6.85)*	0.4269 (4.80)*
CUMGPA	0.0389 (3.05)**	0.0311 (2.41)***	0.0320 (2.48)***	0.0133 (1.17)	0.0071 (0.63)
AGE	-0.0072 (-1.47)	-0.0086 (-1.75)	-0.0086 (-1.76)	-0.0031 ((-0.74)	-0.0019 (-0.46)
LOAD	0.0004 (0.17)	-0.0000 (-0.02)	0.0000 (0.01)	0.0031 (1.34)	0.0035 (1.56)
GENDER	0.0072 (0.43)	0.0073 (0.44)	0.0058 (0.35)	0.0038 (0.26)	0.0069 (0.48)
RACE	0.0080 (0.40)	0.0130 (0.66)	0.0158 (0.80)	0.0261 (1.53)	0.0217 (1.29)
TECH		0.0466 (2.59)***	0.0384 (1.98)***	0.0304 (1.94)***	0.0481 (2.92)**
TECH1			-0.1640 (-1.12)		0.4231 (2.96)**
TECH2				0.7520 (7.72)*	0.9122 (8.32)*
N	182	182	182	182	182
Adjusted R-Squares	0.27	0.29	0.30	0.47	0.50

This table reports the results of regressing the change in performance over the duration of the course on a series of independent variables. Standard errors are in parenthesis. *, **, and *** denote statistical significance at the 0.0001, 0.005 and 0.05 levels for a two tailed test. EC3 = the difference in exam results posted between the third Exam of the course (E3) and the first exam of the course (E1); E1 = The grade (percentage of correct answers) posted for Exam 1; E2 = The grade (percentage of correct answers) posted for Exam 2; CUMGPA = Cumulative grade point average at the start of the semester in which this Introductory Accounting was taken (4.0 basis); AGE = Age of student; LOAD = Current semester course load; GENDER = Dichotomous variable equals 1 if student is a male and 0 otherwise; RACE = Dichotomous variable equals 1 if African American and 0 otherwise; TECH = Dichotomous variable equals 1 if student was exposed to technology (for Test group) and 0 (for Control group) otherwise. TECH1 = Reflects the product of the Technology exposure and the performance difference between Exam 2 and Exam 1 Performance (TECH * [Exam 2 performance – Exam 1 performance] = TECH*EC1); TECH2 = Reflects the product of Technology exposure and the performance difference between Exam 3 and Exam 2 Performance (TECH * [Exam 3 performance – Exam 2 performance] = TECH*EC2).