ASSESSMENT OF THE IMPACT OF SMART BOARD TECHNOLOGY SYSTEM USE ON STUDENT LEARNING, SATISFACTION, AND PERFORMANCE

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Abstract

Literature on educational technology touts its potential for enhancing student outcomes such as learning, satisfaction, and performance. But are these benefits universal and do they apply to all applications and/or forms of educational technology? This study focuses on one such system, the Smart Board Technology System (SBTS) and the impact its use has on students. Responses from 111 students in a College of Agriculture and Human Sciences at a public university in the Southwest United States yields mixed but encouraging evidence. SBTS use is shown to be positively related to student learning and satisfaction, but not necessarily student performance.

The typical college student of today is a frequent user of information technology. The vast majority (i.e., slightly more than 85%) of incoming Fall 2009 college freshman report proficiency in basic computer use (Heimler, Denaro, Cartisano, Brachio & Morote, 2009). Other recent survey data indicate that the dominant use of information technology by incoming college freshmen is for informal social purposes. Almost 9 of 10 students (89%) report a recent visit to a social networking site and fully three in four maintains a page or profile on one of these sites (College Board and Art & Science Group, 2009). Given the importance of information technology in students' lives, educators have the responsibility to examine how their use of educational technology, or lack thereof, affects student outcomes (e.g., student learning, satisfaction and ultimately performance).

The use of educational technology is now commonplace across almost all educational environments. Technologies used in the university classroom such as wireless internet access, PowerPoint presentation software, interactive multimedia "smart boards," real-time response systems, etc. provide a "media rich" learning environment that the technologically sophisticated college student of today finds appealing. The typical college student has a minimum expectation that technology will be integrated in their classroom environment much as it is already pervasive in their daily lives. In fact, students have come to expect that their professors will use some level of educational technology in the classroom, and if their professors do not, they will negatively evaluate both the course and the instructor (Schrodt & Turman, 2005). These expectations undergird a paradigm shift wherein more traditional lecture-based approaches to teaching and learning are giving way to online and interactive television (ITV) alternatives as well as the use of multi-media digital presentations in the classroom (Collins, 2003; Daughty & Funke, 1998).

Engaging students as active learners is a necessity in order to create an exciting and stimulating learning environment. Students are receptive to educational technology in the classroom if they perceive that it assists them in their studies and the learning process (Wang, 2002). They expect technology to be an integral part of the entire educational process and they desire open access to information (Seeman & O'Hara, 2006). As a consequence, many college classrooms have been transformed into digital, wired environments and there is an ongoing need for professors to use these technological tools to disseminate information and actively engage their students in both active learning and critical thinking and analysis (Fox, 1999; Green, 1999).

Recently, serious concerns about the proper role, effectiveness, and future of educational technology in the classroom have been raised (Mann & Robinson; Young, 2009). In many instances, educational technology has not been adopted in a rationalized or systemic way. Upcraft & Terenzini (1998) caution that educational technology use and its impact on student learning both need to be carefully monitored and evaluated on an ongoing basis. The evidence, or lack thereof, concerning the degree to which formal assessment of educational technology use is actually being done is disconcerting.

In the past, some institutions implemented educational technology systems based on little more than optimistic assumptions and good intentions (Taylor & Schmidtlein, 2000). Unfortunately, some of these systems have proven to be very costly from a maintenance and upgrade perspective. There is troubling evidence that a growing number of institutions are not keeping up in the battle to keep these systems functional and relevant due to budgetary shortfalls. Sadly, smart classrooms are "turning dumb" due to neglect (DeBolt, 2008).

Gone are the days when educational technology investment decisions can be founded on little more than assumptions about the benefits of technology in the classroom. Given the current realities faced by most institutions, it is necessary to be able to demonstrate the efficacy of these systems in influencing important outcomes such as learning, satisfaction, and student performance in order to justify the resources consumed by these systems.

Related Literature

Higher education is a service industry and as such it is imperative that universities meet the needs, expectations, and desires of their most immediate customers -- students (Cheng & Tam, 1997). One perspective suggests that students are the ultimate consumers and their satisfaction with the educational experience is one consequence of the relationship between professors and students (Wang, 2003). Educational technology has the potential for positively impacting both faculty and students and their relationships. Massy and Zemsky (1995) assert that educational technology provides the potential to mass customize the educational experience to accommodate individual student differences concurrent with providing improved convenience for both student and faculty member alike.

Educational Technology: The Smart Board Technology System

The Smart Board Technology System (SBTS) is an incredibly rich, interactive multimedia learning interface. The SBTS is comprised of an interactive smart board screen at the front of the room, a data projector, and a faculty operated multimedia desk. Using the SBTS, faculty users can incorporate and mark up still or moving images from DVD, VCR, document cameras and computer files. Using their finger or a pen, the faculty user can interact directly with material such as reorganizing nodes in a model, graphically illustrating relationships between concepts, or marking up documents in real-time in applications such as Excel, PowerPoint, NetMeeting, etc.

The SBTS possesses other unique capabilities relative to traditional classroom instructional methods. Using the SBTS, all writing, drawings, and notations made on the touch sensitive smart board may be saved, printed and distributed, or e-mailed to the students (Levy 2002; Smith, Higgins, Wall, & Miller, 2005). Try doing that with the content of a traditional blackboard, white board, or flip chart!

Multi-tasking is also easily accommodated by the SBTS. Multiple documents can be displayed simultaneously and multimedia presentations can be integrated, potentially appealing to students with varying learning styles and abilities (Starkman, 2006). The use of the SBTS may enhance the interest and learning of students who find lecture challenging when used as the only means of communication (Somekh, et al., 2007). Through the SBTS, the professor is empowered to transform the classroom setting into a stimulating, dynamic, and collaborative learning environment (Somyurek, Atasoy, & Ozdemir, 2009).

Consequences of Educational Technology Use

What can be said with certainty is that educational technology is expensive. Beyond the obvious costs of hardware and technical support, some other less obvious costs include:

- *Institutional infrastructure* – installing communications networks that link classrooms, buildings, dormitories, and students at off-campus locations together;
- *Faculty training and "opportunity" costs* - most faculty require considerable training;
- *Course design/development costs* - some institutions employ course designers who train faculty while others outsource -- at substantial cost in either case;
- *Administrative/legal costs* - copyright hurdles and privacy and security issues all create costs, sometimes considerable (Taylor & Schmidtlein, 2000).

As universities invest more of their limited funds on educational technologies, they will need more detailed information to guide their investment decisions. Schmidtlein and Taylor (2000) advocate for better planning and analysis by university administrators, but argue that seldom are both the full costs and benefits of educational technology use adequately investigated or addressed. Establishing the benefits of educational technology will increasingly become a necessity in order to garner the substantial resources needed to install and particularly maintain and upgrade educational technology systems. These benefits should not only include an emphasis on cost efficiencies but also the impact that educational technology use has on student outcomes such as satisfaction, learning, and performance.

Previous research suggests that the use of educational technology can result in a variety of beneficial student outcomes such as student satisfaction (Schrodt & Turman, 2005), enhanced learning (Althaus 1997) and higher performance (Alavi 1994; Rutz, Eckart, Wade, & Maltbie, 2003). It is important, therefore, that all these outcomes be examined when determining the appropriate use and impact of educational technology in the classroom environment (Fritz, 2007; Flanigan, 1999; Witmer, 1998; Lane & Shelton, 2001).

Student Satisfaction

Universities have a myriad of stakeholders to please, but the most influential and important is the student. Universities compete for students and the importance of keeping students satisfied is increasingly critical to both the success of the university in aggregate as well as to the students individually. According to Elliot & Shin (2002, p. 198), "student satisfaction refers to the favorability of a student's subjective evaluation of the various outcomes and experience associated with education." Research indicates that a satisfied student will be more motivated to learn and, therefore, will achieve more success in his or her college career. It has also been concluded that if the environment of the classroom fits with the preferences of the students, then satisfaction with the educational experience will occur (Fraser, 1994).

There has long been a debate as to whether increased student satisfaction results in greater academic success or if greater academic success results in increased satisfaction (Pascarella, Whit, Edison, Hagedorn, & Terezini, 1996). Regardless, it has been concluded that student satisfaction will increase if the professor utilizes a variety of communication techniques in the classroom (Irons, Keel, & Bielema, 2002). The student's attitude toward the class may change when the classroom environment encompasses the use of technology to disseminate course information. Students feel that they possess a greater sense of control over their own education if technology is integrated into the course design (Apple Computer, 2002). Although a myriad of factors relate to student satisfaction, it has been concluded that the development and design of the course is the most influential factor affecting student satisfaction (Stein, 2004).

Student Learning

Affective learning is reflected by the student's emotional response to factors such as the professor, the course content and the learning environment; all three of these variables will influence the quality and the amount of information that the student learns in the class (Rodgriguez, Plax, & Kearney 1996). And if there is a positive affect for both the professor and the course, then the student will be more highly motivated to learn (Christensen & Menzel, 1998; Frymier & Hauser, 2000)

Arbaugh (2000) examined the effects of technology, pedagogy and student characteristics on student learning in online MBA courses. The degree of interactivity of the learning environment was found to be significantly positively related to student learning outcomes. In order for learning to take place most effectively, the student needs to be an active rather than a passive receiver of information; required to structure, manipulate and analyze information. Educators as well as students believe that the utilization of various forms of educational technology in the classroom environment both facilitate learning and the ability to apply knowledge in an analytical manner (Alavi, 1994).

Affective learning is one student outcome that is specifically related to the professor's mode of communication and instruction (Arbaugh, 2000; Kearney, 1994). Learning can be enhanced if both audio and video are introduced into the classroom through the use of educational technology Cognitive flexibility theory (Jacobsen & Spiro 1995) posits that students will learn more effectively if complicated information is presented to them in a variety of formats (Hall, Watkins, & Eller, 2003). Mayer (1997) contends that introducing both video and audio into the classroom environs enhances the learning process because students can process audio and video images independently. In fact, students can absorb and learn complicated information more readily if it is presented to them in varying mediums (Hall et al., 2003; Perry & Perry 1998; Reinhardt 1999).

Fore example, Switzer and Csapo (2005) concluded that iPOD use in the classroom environment provided a more engaging atmosphere and motivated students to learn. The device appeared to be a tool that encouraged and facilitated information sharing and team-building skills among students. This is supported by media richness theory which contends that the use of multimedia technologies do provide a more stimulating and enriching classroom than lecturing alone.

Student Performance

In the literature related to the use of educational technology and performance, final course grades typically are used as a measure of the performance outcome. Final course grades are considered a valid measure because they are quantifiable and are directly related to the student's experience with the course (Rutz et al., 2003). In one study, Alavi (1994) used two comparison groups to determine the impact of computer mediated courses on final course grades. Students in multiple sections of the same course who were exposed to computer mediated learning, relative to those students who were not exposed, received significantly higher final grades in said course.

Rutz et al. (2003) also evaluated the utilization of various forms of educational technology in order to determine if they improved the student learning process. The ultimate goal of the study was to improve student performance through the use of technologies in the classroom. Final course grades where educational technology was used in the classroom were compared to grades for the same course where traditional teaching methods (e.g., lecture) were used. It was concluded that time on task and interest in content were improved when educational technology was used in the classroom, and that this could result in higher student performance.

Instead of the final course grade, Noppe, Achterberg, Duquaine, Huebbe and Williams (2007) used individual exam scores as the measure of course performance. The study evaluated the impact of distributing PowerPoint handouts prior to lecture coverage in class. The researchers found that distributing the PowerPoint handouts had no significant effect on student performance in spite of their evidence that the student respondents believed that the handouts had a large influence on their performance. The authors noted concerns that handout distribution may ironically diminish the efficacy of the note-taking process.

Purpose of the Study

Prior to adopting or updating technology in the classroom, there is a need for critical research to be conducted in order to determine the educational efficacy of specific educational technologies (Flanagin, 1999; Witmer, 1998; Lane & Shelton 2001). Given the bleak budgetary outlook that many institutions of higher education currently face, assessing the efficacy of educational technology may prove key in being able to justify the sizable investment of resources it requires to implement and maintain these systems.

While cost is an important consideration, the most important benefit of using educational technology is not necessarily cost efficiencies that may be created, but improved student learning (Laurillard, 2007). According to Hetrick: "… we must find our way out of the tar pit of justifying technology applications because they demonstrate tangible cost savings and into the integration of technology because it significantly improves the learning process" (1991, p. 12).

The purpose of this study is to investigate whether a relationship exists between college faculty's extent of use of the Smart Board Technology System (SBTS) and student outcomes. Specifically, this study will explore and measure the impact of SBTS use on the satisfaction, perceptions of learning and performance outcomes of university students. The specific research question addressed by this study is: Does a professor's use of the SBTS affect student outcomes? The following three research questions will be addressed.

Q1: Is extent of SBTS use associated with student perceptions of learning in the course?

Q2: Is extent of SBTS use associated with student satisfaction with the course?

Q3: Is extent of SBTS use associated with ultimate course performance?

Methodology

The sample used in this study consisted of students, both graduate and undergraduate, enrolled in courses in a College of Agriculture and Human Sciences at a moderately-sized public university in the Southwest United States. This setting was chosen because one of the authors served as a graduate assistant/technical support liaison in this college and had extensive knowledge regarding actual faculty use of the SBTS in the college.

The Survey

An original twenty-one item survey instrument was designed for purposes of data collection. Three multiple-item scales were used to measure the three constructs of: (1) *extent of SBTS use* – three original items, (2) *student perceptions of learning* - six items modeled after Alavi (1994), and (3) *student satisfaction with the course* - five items modified from Arbaugh (2000). Two items were used to measure *student performance* and the remaining items were comprised of demographic items.

The survey items consisted of a mixture of five-point Likert scales, category scales and simple dichotomy scales. To mitigate mono-method bias, some of the items on the multiple item scales were reverse scaled and the ordering of the multiple measurement items was randomized throughout the survey.

Sampling and Data Collection

Based on previous survey results concerning faculty experiences with the SBTS, fifteen faculty representing a continuum of SBTS use were selected as the primary "clusters" for this study. To be more precise, the courses offered by these faculty served as the primary clusters. Data were collected during the last three weeks of the Spring 2007 semester so that student respondents would be able to reliably estimate their final course performance (i.e., anticipated course grade).

The participation of the selected faculty members was solicited both in person by one of the authors and through a memorandum from the dean of the college. Each faculty member was asked to distribute a memo to the students in his or her class. The student memo explained the purpose of the study and invited the student respondents to visit a website where they could complete an online survey. The online survey began with an operational definition of the SBTS and students were informed that the survey had been approved by an institutional review board and that their anonymity was assured.

Data Analysis

Respondents were profiled on all demographic variables through the use of frequency distributions. The multiple item measurement scales were purified via item-scale correlation and reliability analyses to provide evidence as to their construct validity.

The first two hypotheses were tested via multiple stepwise regression models, one each for the dependent variables of student perceptions of learning and student satisfaction with the course. The demographic variables of gender, age, and student type (i.e., self-described A student, B student, etc.) served as control variables in these regression models. Collinearity diagnostics were analyzed in order to protect against the undesirable effects of multicollinearity.

Due to concerns about grade inflation and its effect on the distribution of responses on the student performance surrogate (i.e., anticipated course grade), the third hypothesis was tested using both Spearman's rank-order correlation and the Mann-Whitney U-test; nonparametric tests that do not require restrictive assumptions about the distribution of the variable(s) under analysis.

Results

Sample Demographics

It is difficult to estimate a response rate for the survey. Were one to use as a base the total enrollment in all of the courses taught by the fifteen selected faculty, there is the possibility for significant over-counting of potential respondents due to the fact that students majoring in this college would likely be taking multiple courses offered by the college simultaneously. Because responses were anonymous, it was not possible to match students across multiple sections to eliminate the double-counting. The only thing that can be said with any certainty is that 111 usable surveys were completed. Table 1 profiles the respondents on the demographic characteristics.

Table 1.
Sample Demographics

Characteristic	*Levels*	*Number*	*Percentage*
Gender	Male	47	42.3
	Female	64	57.7
Class	Freshman	10	9.0
	Sophomore	7	6.3
	Junior	44	39.6
	Senior	45	40.5
	Graduate	5	4.5
Age	19 or under	12	10.8
	20-21	38	34.2
	22-23	36	32.4
	24-25	13	11.7
	26 or over	12	10.8
Student Type – self described	F student	0	0
	D Student	0	0
	C Student	7	7.2
	B Student	72	64.9
	A student	31	27.9
Anticipated Course Grade	F	0	0
	D	1	0.9
	C	17	15.3
	B	42	37.8
	A	51	45.9

Two things stand out about the respondents. First, the sample consisted largely of upper division undergraduates as more than 8 in 10 respondents were either a junior or senior. Secondly, grade inflation is evident. Note that only 16.2% of the students expect to earn a grade less than B in the course that they are rating. In addition, note that 92.8% of the students consider themselves to be either an A or B student overall.

Scale Purification

Three summated scales (i.e., 1] student satisfaction or "SATIS", 2] student perceptions of learning or "LEARN", and 3] extent of SBTS use or "SBTSUSE") were created by averaging the multiple items assigned to each measurement scale. Next the summated scales were subjected to reliability analysis in order to determine the internal consistency of the multiple measurement items assigned to each scale. It has been suggested that original scales (i.e., the SBTSUSE scale) exhibit a minimum reliability coefficient alpha of 0.60 or greater (i.e., $\alpha \geq 0.60$) and that replicated scales (i.e., the SATIS & LEARN scales) exhibit a minimum coefficient alpha of $\alpha \geq 0.70$ (Nunnally, 1978). Referring to Table 2, note that all scales meet these requirements. In the case of the LEARN scale, one scale item was deleted in order to improve scale reliability.

Table 2.
Reliability Analysis Results

Scale	*Label*	*Final Number Of Items*	*Reliability Coefficient (Cronbach's α)*
Student satisfaction	SATIS	4	0.762
Student perceptions of learning	LEARN	5	0.920
Extent of SBTS use	SBTSUSE	3	0.734

The final step in the scale purification process involved the computation of item-scale correlation coefficients in order to examine the data for the desired pattern of individual survey items correlating with their intended scale to a greater degree than any alternative scale. This pattern provides evidence of construct validity in that it establishes that survey items consistently represent one, and only one, distinct concept/construct.

One item on the satisfaction scale was deleted because it exhibited very high correlations with multiple summated scales. After this deletion, all remaining measurement items exhibited the desired pattern of correlating with their intended scale to a greater degree than any alternative scale, all by a wide margin.

Profile of Key Variables

The analysis turned next to the focal construct of the study - extent of SBTS use. As noted before, responses were averaged on the three items comprising this scale to create a summated scale (SBTSUSE). Table 3 profiles the participating faculty concerning their extent of SBTS use as reported by the student respondents.

Table 3.
Student Ratings of the Extent of SBTS Use by Faculty

Average Scale Value	*Descriptor*	*Number*	*Percentage*
1 - 1.99	Very Infrequently	4	4.0
2 - 2.99	Infrequently	9	8.9
3 - 3.99	Neither Frequently nor Infrequently	34	33.7
4 – 4.99	Frequently	38	37.6
5	Very Frequently	16	15.8

Based on responses to a former survey of these same faculty concerning their use of and experiences with the SBTS, the faculty were classified a-priori into groups of "high SBTS use" and "low SBTS use" by the author that had served as a technical support specialist in this college. A t-test was performed to test for a significant difference in the average SBTSUSE scores between the two a-priori groups and it was found that the average SBTSUSE score was indeed significantly ($p = 0.01$) greater for the "high SBTS use" versus the "low SBTS use" group, providing affirmative evidence of criterion validity.

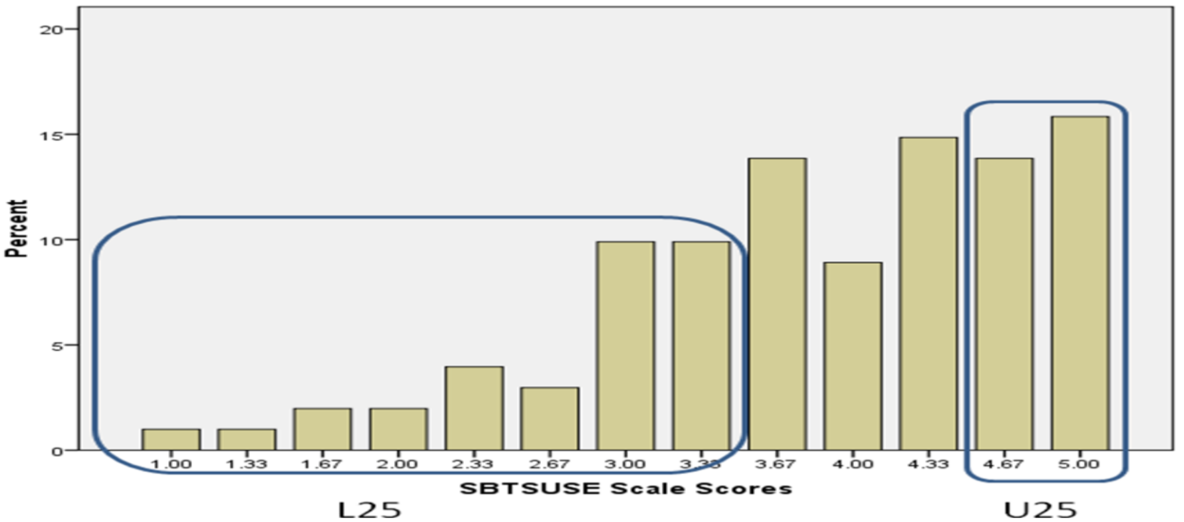
Figure 1 provides further insight into the distribution of SBTSUSE scores. Not surprisingly, the distribution of scores is negatively (left) skewed indicating that most faculty have achieved higher levels of reported SBTS use. The distribution reflects the reality of a faculty that had, in the main, gotten on board in using the SBTS system.

To facilitate further data analyses, a dichotomous variable was created reflecting low extent and high extent of SBTS use. To create the two groups, first quartile (i.e., "L25") and fourth quartile (i.e., "U25") scores were identified for the scores on the SBTSUSE scale, as summarized in Table 4 and these two groupings are also illustrated in Figure 1.

Table 4.
High (U25) vs. Low (L25) Extent of SBTS Use Groups

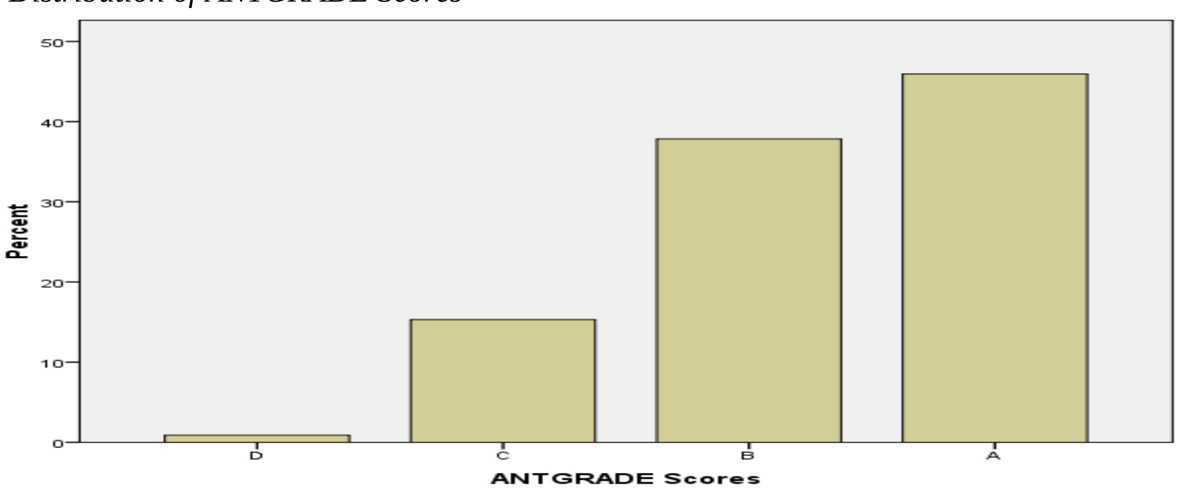
Group	*Quartile*	*Label*	*Number*	*Average SBTS Scale Score*
Low SBTS use	1st	L25	33	3.33 & below
High SBTS use	4th	U25	30	4.67 & above
			63	

Figure 1.
The Distribution of SBTSUSE Scale Scores



Turning to the outcome variables, responses on both the student satisfaction (SATIS) and student perceptions of learning (LEARN) scales are approximately normally distributed and present no concerns as relates to the application of parametric statistical tests. The same cannot be said for the student performance surrogate of anticipated course grade (ANTGRADE). As is clearly evident in Figure 2, the grade inflation phenomena resulted in a highly skewed distribution. A Kolmogorov-Smirnov Z-test was conducted and verified that indeed the distribution of ANTGRADE scores is highly non-normal (KS=3.02, p=0.000). It may even be a considerable stretch to consider the ANTGRADE variable to be continuous in nature. In order to avoid making troublesome assumptions about the ANTGRADE variable, nonparametric tests were selected to test the third research question regarding the extent of SBTS use and student performance.

Figure 2.
The Distribution of ANTGRADE Scores



Q1: Is extent of SBTS use associated with student perceptions of learning in the course?

A stepwise multiple regression model was constructed to model the variation in student perceptions of learning (LEARN) as a function of the extent of SBTS use (SBTSUSE) using the demographics of age, gender, and student type (i.e., STUTYPE = A student, B student, etc.) as control variables. The final model retained only one independent variable (SBTSUSE), is highly significant (F=56.2, p=0.00), and explains a sizable thirty-seven percent of the variance (r^2=0.37) in student perceptions of learning. Collinearity diagnostics indicate no particular concerns as each variance inflation factor (VIF) for the retained variables is well below the threshold value of ten (Hair et al., 2006). Table 5 summarizes the model output.

Note that extent of SBTS use (SBTSUSE) is highly related to student perceptions of learning (LEARN) but that none of the demographic variables have any predictive value. The simple correlation coefficient between SBTSUSE and LEARN is a sizeable r=0.61 and is highly significant (p = 0.00).

Table 5.
Student Perceptions of Learning (LEARN) Regression Model

Variable	*Beta Coefficient*	*t-statistic*	*p-value*	*VIF*
INTERCEPT	0.953	5.187	0.000	N/A
SBTSUSE	0.614	7.496	0.000**	1.000
AGE	0.100	1.234	0.220	1.000
GENDER	-0.106	-1.310	0.194	1.014
STUTYPE	-0.042	-0.516	0.607	1.004

** Significant at the 0.01 level

Q2: Is extent of SBTS use associated with student satisfaction with the course?

A second regression model was constructed to model the variation in student satisfaction with the course (SATIS) as a function of the extent of SBTS use (SBTSUSE) and student perceptions of learning (LEARN), using the demographics of age, gender, and anticipated course grade (ANTGRADE) as control variables. The final model retained two independent variables (LEARN and SBTSUSE), is highly significant (F=49.5, p=0.00), and explains a substantial fifty-one percent of the variance (r^2=0.51) in student satisfaction with the course. Collinearity diagnostics indicate no area of concern as each variance inflation factor (VIF) for the retained variables is well below the threshold value of ten. Table 6 summarizes the model output.

Table 6.
Student Satisfaction (SATIS) Regression Model

Variable	*Beta Coefficient*	*t-statistic*	*p-value*	*VIF*
INTERCEPT	0.737	4.788	0.000	N/A
LEARN	0.480	6.519	0.000*	1.548
FREQUSE	0.164	2.157	0.034**	1.548
AGE	-0.035	-0.479	0.633	1.015
GENDER	-0.002	-0.024	0.981	1.040
ANTGRADE	-0.023	-0.299	0.765	1.151

* Significant at the 0.05 level
** Significant at the 0.01 level

Note that both perceptions of learning (LEARN) and extent of SBTS use (SBTSUSE) are significantly related to student satisfaction with the course (SATIS). From a practical perspective, perceptions of learning (LEARN) is a much more substantial contributor to satisfaction as its Beta coefficient is about three times that for the extent of SBTS use (SBTSUSE). It is heartening to see that students appear to value learning as it is so strongly related with their satisfaction.

Q3: Is extent of SBTS use associated with ultimate course performance?

Former studies report evidence of a positive link between the use of educational technology and student performance in the form of course grades (e.g., Alavi, 1994, Rutz et al., 2003). In this study, anticipated course grade (ANTGRADE) is a weak surrogate for student performance compromised by the obvious restriction of range and distributional anomalies owing to the grade inflation tendency previously noted. Accordingly, nonparametric tests were used to sort out the final research question.

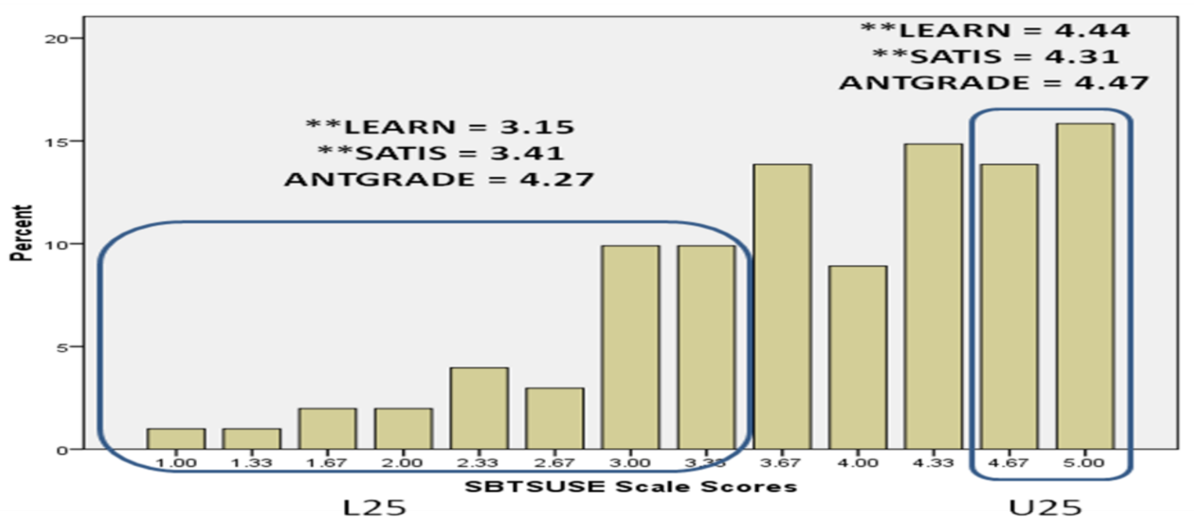
Spearman’s rank order correlation (i.e., Spearman’s rho or ρ) is a nonparametric measure of association that does not require restrictive assumptions about the distributions of the variables under analysis. Extent of SBTS use (SBTSUSE) and anticipated course grade (ANTGRADE) scores were correlated resulting in a Spearman’s $\rho=0.127$ which proved non-significant ($p=0.206$).

In order to further test the relationship between SBTSUSE and ANTGRADE, the two groupings of “low SBTS use” (i.e., L25) and “high SBTS use” (i.e., U25) were used. The Mann-Whitney U-test was used to test for a significant difference in the ranked ANTGRADE scores for the L25 versus U25 groups. The Mann-Whitney U-test can be thought of as a nonparametric equivalent of the simple *t*-test as it is used to test for a significant difference in the medians of two groups; the *t*-test uses mean scores instead. While the high SBTS use (U25) group did exhibit a higher average rank score than the low SBTS use (L25) group (i.e., 33.87 vs. 30.30 respectively) this difference proved non-significant (U=439.00, p=0.396). The data simply do not support a conclusion of a positive impact of SBTS use on student performance.

Discussion and Caveats

To better illustrate the impact of SBTS use on the outcome variables of student perceptions of learning (LEARN), student satisfaction with the course (SATIS), and student performance (ANTGRADE), the L25 and U25 groupings were used one final time. Figure 3 presents the average scores on these three outcome variables between the L25 vs. U25 groups.

Figure 3.
Mean Outcome Variable Scores: L25 vs. U25



*** Significant at the 0.01 level*

Extensive use of the SBTS clearly results in better outcomes in the case of student perceptions of learning (LEARN) and student satisfaction with the course (SATIS). The observed difference in the means between L25 and U25 groups is pronounced for both of these outcome variables and the differences proved highly significant (i.e., p=0.000) in both cases when subjected to a *t*-test. This study provides confirmatory evidence that the use of educational technology (i.e., the SBTS in this context) is positively associated with improved outcomes in terms of student learning and student satisfaction.

In the case of student performance (ANTGRADE), the U25 mean anticipated grade is indeed greater than that for the L25 group (4.47 vs. 4.27 respectively), at least in nominal terms. Note that the difference in the means is small from a practical perspective. And not surprisingly from a statistical perspective, that difference proved non-significant (p=0.293) when subjected to a *t*-test. The results of this study cannot confirm prior literature finding a positive association between the use of educational technology and improved student performance. This finding merits additional discussion.

In previous studies, student performance has been operationalized using either a final course grade or exam scores. In these studies, a faculty member has implemented contrasting instructional methods (i.e., traditional vs. enabled with educational technology) then looked at the impact on student performance in either the form of exam scores or final course grades. In these studies, the faculty member had perfectly reliable knowledge concerning these outcomes, but this came at the expense of limiting the sample to a nonprobability sampling of a group of students taking courses from a singular faculty member at one institution.

Due to resource constraints and privacy concerns, the approach described above is simply infeasible if the objective is to sample a variety of students at randomly selected institutions. Thus, this study provided a first step in a different direction. This study relied on a student self-report of the anticipated course grade and this approach may perhaps have compromised the reliability of the student performance outcome variable. The finding of a non-significant association between the use of educational technology (i.e., the SBTS) and student performance in this study may largely be an artifact of what has just been described.

Certainly a larger sample would have proved beneficial and it is likely that the grade inflation observed in the sample of this study contributed to the non-significant finding. A larger sample of students from randomly selected institutions would almost certainly attenuate the grade inflation problem. This study provides a first step in that direction and represents a contribution in terms of validating the instrumentation and refining the methodology.

Conclusions

A number of forces have converged that jeopardize the future of educational technology use in the classroom and educational technology certainly has its detractors among administrator and faculty ranks (Young, 2009). Increasingly, decision makers will want evidence that educational technology does indeed enhance important student outcomes like learning, satisfaction, and performance. And using educational technology may prove to be a differentiating factor as institutions attempt to attract and retain their customer base of students. In fact, Schmidtlein and Taylor (2000) have predicted that universities not using educational technologies will face declining enrollments as their customers go elsewhere seeking more stimulating learning environments.

Educational technology use may also be impeded by skeptical faculty who resist its use even though, ironically, it is likely to improve instruction and learning. This resistance may be due to nothing more than the weighing of the time it takes to integrate educational technology in the classroom against all other obligations (e.g., research, service, class preparation, etc.). It is the professor, however, who is the linchpin for using educational technology in order to facilitate student engagement and learning (Armstrong et al., 2005). A strong case needs to be made to faculty that using educational technology does make a positive difference for their students. Many faculty may be skeptical or unclear as to whether this is so and the case deserves making.

Institutional budgets are tight and will continue to be so for the foreseeable future. A generation of “smart” classrooms is reaching the stage where significant upgrade or replacement is a necessity. No longer can decisions to invest or re-invest in these systems be made solely on optimistic assumptions concerning educational technology use in the classroom. In this new age of formal assessment and accountability, it is imperative that both the cost and benefits of these investments be studied and determined (Johnstone & Poulin, 2002). In this environment, formal assessment of educational technology systems and their impact on students may provide the foundation for making the case for educational technology investments.

This study is illustrative of a formal educational technology assessment. The results of this study confirm the findings in the literature that the use of educational technology is positively related to student learning and satisfaction. In the context of this study, the educational technology took the form of the Smart Board Technology System (SBTS), and use of this system was positively associated with student perceptions of the learning that occurred in the course and with satisfaction with the course overall. Interestingly, the impact of student learning on student satisfaction was relatively large and it is encouraging to see that learning is such an instrumental determinant of students' overall satisfaction.

Student performance was not found to be associated with the extent of SBTS use in the classroom. This finding is perhaps an artifact of limitations of this study's measure of student performance, modest sample size, and the grade inflation noted in the sample. But this study provides a foundational first step to conducting broader studies involving a larger, randomly selected sample of student respondents.

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