RUNNING HEAD: Technology and Education

Are Classrooms Really Smarter?

A Look at Today's Educational

Technology and Its Impact on Teaching and Learning

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Abstract

The push to outfit classrooms with the newest technology has caused K-12, colleges and universities to invest millions of dollars into new equipment. These new technologies offer instructors many different ways of communicating information to students, often in an asynchronous, digital format. Key technologies and the impact they are having on teaching and learning at today's universities are outlined. In addition, the thrust towards a digital environment has altered the learning landscape, and now more than ever it is critical that university professors are well-versed in good teaching pedagogy and well-trained at technology integration. Several advantages and disadvantages of technology-use in the classroom are also addressed.

Introduction

Today's classrooms are changing faster than ever before in the history of education. The blackboards, overhead projectors, notebooks and TV sets of yesterday's classrooms are rapidly being replaced by high-tech SMART boards, digital document cameras, laptops/tablets and high resolution image projectors. These new technologies offer instructors many different ways of communicating information to students, and this paper seeks to outline several key technologies and the impact they are having on teaching and learning at today's universities and K-12 schools. The paper is broken into several key sections: a technical overview of the different types of technology-enhanced (smart) classrooms, an analysis of the changing learning environment spurred by technology changes, a pedagogical review of teaching and learning with technology, and an analysis of the advantages and disadvantages of technology-enhanced classrooms for both students and instructors.

Technology-Enhanced Classrooms

High-tech classrooms come in many different configurations and by almost as many names, such as "smart classrooms", "technology-enhanced" and "electronic classrooms" (Berque, Bonebright & Whitesell, 2004). Simply stated, any of these terms pertain to a classroom that uses computer-based technology that is integrated into the lessons to augment instruction. While the same term may be applied to any technology-enhanced classroom, there are four basic levels of technology enhancement being used today and it is useful to categorize classrooms into these levels.

Level 1 is the coupling of a PC (desktop or portable computer) with a digital projector displaying an image onto a screen or even a blank wall. This setup has become commonplace in schools and universities as the price of entry-level projectors and computers have dropped to below $3000 for a nicely equipped laptop, wireless mouse and projector. Level 1 setups most often use presentation software such as Microsoft's PowerPoint to display information on the screen for students. Presentation programs can include graphics, pictures, even movies, but lack the ability for instructors to modify the information easily or on the fly. Instructors are the central distributor of information and this Level of classroom is usually well-suited to lecture-based courses.

Level 2 introduces the electronic whiteboard, often called a "SMARTboard" after one of the largest distributors, SMART Technologies. The electronic whiteboard replaces a chalkboard or dry-erase whiteboard by capturing the pen markings on the screen to the computer. By hooking up the electronic whiteboard to a computer and projector system, you can project your slideshow or images onto the electronic whiteboard, then use the pens to annotate the information, and have all of this information including your changes, saved on the computer. These boards seek to change the way in which instructors and students interact with the material allowing for hand-drawing or "digital ink" to clarify points, create diagrams, or illustrate relationships between objects on the screen (Domermuth, 2005). Student computers running the electronic whiteboard software connected to the network, can receive the instructor's modified notes and save them on their own computers in real-time.

Level 3 moves forward another step by introducing a pen-based computer that allows for both the instructor and student to create digital ink on documents. With the power of different types of collaboration software such as Classroom Presenter and DyKnow, instructors can not only mark up the presentation that they are giving, but can send information directly to the student computers, have them make changes, and then they can send it back to the instructor for comments or for display on the main screen (Anderson, Anderson, Simon, Wolfman, VanDeGrift, & Yasuhara, 2004). This fundamentally alters the type of interaction occurring in the classroom, from an instructor-centered room (often referred to as "sage-on-the-stage") to a more collaborative, problem-solving environment. Students can also now make their own markings on information being presented, which allows them to take ownership of their learning and draw connections that make sense to them (VanDeGrift, Wolfman, Yasuhara, & Anderson, 2002).

Level 4 technology-enhanced classrooms have all of the features of Levels 1-3, but also include more technologies and arrangements to allow for non-lecture based instruction. These high-tech rooms have A/V equipment that can allow for video-conferencing with outside subject-matter experts, audio and/or video equipment that can record lectures and stream or archive them for later accessing on the web. Other systems currently popular in these rooms include student response systems (SRS) such as Turning Point and eInstruction that allow instructors to pose questions during their teaching sessions which students can answer using a remote control or a computer-based program. These allow for instructors to ask simple probing questions, as well as structure more complex data analysis and assessment, completely on the fly (Beatty, 2004). Other features of Level 4 classrooms might include microphones throughout the room to pick up sound from any location, flexible tables instead of individual desks, raised areas that allow for cabling for large numbers of power outlets and network connections to accommodate every student in the class. Instructors will often have a control board in the front to manage all the multimedia technology in the room without having to plug and unplug each of the features. Level 4 rooms are meant to deal with the demands of today and plan for the future by combining aspects of a classroom, digital recording studio, and conference room. The combination of technologies, when used well, blend the advantages of new digital based technology with the best aspects of the traditional styles of non-technology enhanced teaching (Picciano, 2002).

21st Century Learning Spaces

Traditional learning environments at universities and K-12 schools involved time spent in a classroom where information was transmitted from teacher to student, and then intensive outside-of-the-classroom integration and augmentation of information (Strauss, 2002). Previously, this interaction meant that students would read textbooks, complete assignments, possibly collaborate or meet with other students for cooperative learning and sharing of information. The bulk of the synthesis and problem-solving was occurring outside of the classroom, not guided by the professor in class.

However, with the advent of wireless network technology, web-based digital documents, digital textbooks, video-conferencing and digital communication tools like instant messaging, bulletin boards, and blogs the learning space itself is becoming a mobile concept whose location determined only by the requirements of the computer and the network access. As instructors move towards creating more digital copies of documents and materials accessible from the web, students no longer have to carry around all of their information in the form of a notebook, textbook and tape recorder. Digital copies of lectures in audio form can be downloaded. Notes from classes, assignment outlines, syllabi and more can be accessed on the fly from their computer. Notes from many different courses could be stored on a laptop making several years worth of college work searchable in seconds. Students can form online study groups that exchange questions, share information, and reflect upon course material through chats, message boards, and more. Distance education classes even eliminate a live instructor as content is streamed or archived on the web for students to review and integrate at a time that is more convenient for them.

These technologies are transforming the learning space away from being an instructor-centered dissemination of information to a more collaborative, student-centered approach. Different channels of learning are being made available to the student which can be accessed outside of class time. This integration of information into digital form could be easily transformed into a basis for an electronic portfolio of learning that would help guide both students and universities in creating a more fulfilling educational experience for all students. With a portfolio, students could track different objectives and goals for their own education, while creating products and learning skills that will help them succeed. Thus the portfolio has the potential to be both a learning process and tool, but also a showcase and archive that reflects the benefits of a student's education at a K-12 or university institution.

As learning spaces for students continue to become more student-centered and technology-dependent, instructors will continue to need to change how they create learning activities and content for their courses. On the face of it, these may seem threatening to some instructors who are disinclined to give up being the central figure in a student's learning experience, but technology does not replace an instructor. While more informal learning can be beneficial to a student, instructor-led discussion, explanations and discussions still are major parts of the learning process for students (Berge, 1995). Even distance education courses that do not have synchronous or face-to-face interaction between the instructor and students require that instructors guide the students through the learning path with probing questions, structured discussions, and reflective assignments (Berge, 1995). Thus, students in asynchronous learning environments shoulder more responsibility for self-paced learning, but the instructor still plays a critical role in creating the learning environment.

Pedagogy of Teaching and Learning

Another big problem with college instructors is that most of them lack any formal training in teaching and learning methods and pedagogy. All instructors at the university level need to receive formal training in teaching. Howard Strauss (2002) illustrated this point succinctly by stating “First grade teachers teaching addition to 6-year-old children have more training in pedagogy than a tenured professor teaching advanced calculus at a research university” (p. 13). While we are pouring thousands of dollars into technology-enhanced classrooms, we are failing to address the real problem facing higher education—how to teach more effectively to raise student performance. Graduate students that survived the Ph.D. process were a self-selecting group with already highly developed study skills, and not the most talented teachers. Professors are not rewarded highly enough for good quality teaching, and new faculty are not given enough training in teaching methods.

Not only are professors under-prepared as a whole, students are also unprepared to navigate the vast sea of information assaulting them. Students need to be taught how to take effective notes, organize information, and deal with the digital sea of information floating around them (Strauss 2002, Kiewra, 1985). PowerPoint slideshows packed full of information that students cannot possibly integrate in a single teaching period pervade on today’s university campuses. If instructors were simply taught how to present instructor notes to students effectively instead of just printing out all the slides, student learning could be increased. The advent of the pen-based digital collaboration systems like DyKnow and Classroom Presenter are beginning to address this problem and will be discussed momentarily. If both instructors and students would receive even 30 hours of formalized instruction in teaching and learning methodologies and how to deal with digital information, the impact on student learning might be far greater than any smart classroom. Just because a student can create a flash animation or HTML webpage, that does not mean they are any better able to traverse the digital information landscape than they would know how to find information about a subject in a library of books written in a language they do not understand.

Why Use Technology-Enhanced Classrooms?

Despite these drawbacks, technology-enhanced classrooms are not a bad idea. While outfitting even a single classroom can cost many thousands of dollars, the potential benefits when used in concert with sound education principles, can be great. Well planned lessons integrating technology are often more engaging, memorable and inspiring to students (Tornabene, 1998). Several advantages to using technology are: diversity of sources and types of information, positive effects on student affective and cognitive responses to materials, and the ability to model through virtual spaces (like laboratory experiments or 3-D models) in ways that may be time-consuming, dangerous and expensive in the real world. This applies especially to subsets of students that might be struggling or have learning disabilities (Maccini, Gagnon, & Hughes, 2002). Let me discuss each of these areas in more detail one at a time.

Technology-enhanced classrooms are chocked full with all kinds of gadgets for teaching and learning one can be completely overwhelmed. Between internet connections, digital projectors, laptop computers, tablet PCs, smartboards, video conferencing, audio and video recording, and student response systems (SRS), it is hard for anyone to make sense out how to use them to effectively reach students. But, given some good planning and teaching strategies, professors can enhance teaching and learning through these technologies. The access to more types of media and graphics than ever before and to have those pieces downloadable and accessible before and after class sessions allows students to review and augment their notes in class. Studies have shown that student notes are usually incomplete, and giving them access to instructor notes and supplementary materials can increase student learning (Kiewra, 1985, Barnett, 2003). Level 1 classrooms can include audio, video and other primary and secondary sources of information, conferencing with distant subject matter experts and presenters and more. While this may duplicate what existed in classrooms in the past with audio and video tapes, the ability to make it available for further review after the class has ended, changes how and where students can learn (Strauss, 2002). Podcasting can now capture audio recordings on just about any digital recording device, smartboards and other pen-capture devices (Luidia.com is another example) can annotate notes and save those "digitally inked" presentations for later use by students.

However, even with digital inking, the learning system is still lecture-based, "sage-on-the-stage" style teaching. PowerPoint has locked professors into a 1-way transmission of information and left teachers hard pressed to add their own hand-written notes to the pages. All of that has changed with the advent of pen-based computers and software that runs on them to allow 2-way sharing of information between students and instructors. This move from a Level 1 interaction style to Level 3, which lets students problem solve, write their own notes on the digital display, and transmit that information real-time back to instructors for comments or display. Research has shown that this problem-based approach using technology can benefit student learning outcomes (Yau, S., Gupta, S., Karim, F., Ahamed, S., Wang Y., and Wang, B. 2003). New software from Luidia, DyKnow and Classroom Presenter finally allows the computer to mimic natural note-taking, and marries instructor-provided outlines or notes directly with the computer. Students no longer have to print out notes and write on them by hand, thus defeating the purpose of a digital copy, or type their own outlines to accompany instructor materials. Problems can be posed by an instructor and solved directly in class, and reviewed and commented on. This changes the structure of a course from instructor-centered to more student-centered. An example of this kind of lesson from Classroom Presenter is shown in Figure 1.

Figure 1: Problem Solving using instructor problem and digital ink & colors (Anderson et. al 2004)

A student's laptop can actually become a digital storehouse with the ability to cross-reference notes from several courses by keywords and flags you can set (e.g.: OneNote 2003 from Microsoft). The future of this type of computing could also include all-digital textbooks and course materials, meaning the laptop and an internet connection would be the only requirements. While the all paperless promise was made back when email hit the workplace, it seems likely that educational institutions would embrace this system as it would tie directly into electronic portfolio assessment (Draper 2001, Wetzel & Struder, 2005). Students would be assembling information throughout their career that ties directly into educational objectives for their major or university, which would summarize their learning and help students understand the path there are taking. While portfolios are not easy or quick to implement, several companies are now producing products to help educational institutions implement portfolios through web-based solutions.

In addition to collaborative, 2-way communication that allows for problem solving, student response systems (SRS) are a new technology that allows students to answer questions and instructors can interactively poll that information and display the results real-time on the screen in front of them. Information as simple as “does this concept make sense?” or as complicated as quiz questions and demographic data can be collected and stored by these systems. Each keypad has a unique ID that can be used to compile and track data throughout a course, enabling smart and simple assessment and data collection to conduct research on teaching and learning outcomes. The SRS technology could be simply used to generate interest in class by posing anonymous questions allowing students to venture guesses without being singled out. The ability to track that data and analyze how people are answering in class compared to how they do on exams potentially could become a very useful tool for comparing in-class versus exam performance or other measures. Scaffolded lessons and live data aggregated into sub-groups (majors versus non-majors for example) can provide professors to get valuable feedback on their lessons. Well-devised questions throughout lessons would transform a lecture into a knowledge construction session instead of simple information delivery.

All of these technologies offer the promise of increased student involvement and performance. The move towards a flexible learning space and digital classroom means that student access becomes a more integral part of information assembly. Whereas in the past a student might simply get a printed out syllabus, put it in their notebook, and carry that notebook everywhere they studied, today's students are relying on digital documents to be available for around-the-clock access from websites (Ruberg, Taylor, & Moore, 1996). Students also have shown a preference for more dynamic presentations with richer content information. In one study, over 85% of students in a nursing course preferred the electronic whiteboard and digital projector because it allowed them to see pictures of the heart in color and annotate each section far more clearly (Tornabene, 1998). The ability to display charts, graphs, equations and other multimedia and annotate and draw on the objects, and have them instant transmitted to the student computers does represent a significant change in the way educational-technology can be employed in classrooms

Students also can participate in virtual labs and practice using materials that might be too dangerous, expensive or otherwise restrictive to regular lab use (Strauss, 2002). Practicing hypothesis testing through virtual simulations in the sciences, math, and arts has great potential. Students in a business course could run virtual model of buying and selling behaviors and engineering students can test loads on structures based on parameters and see them modeled in 3-D. This gives professors far more flexibility to truly have students explore their knowledge and actively construct their own learning.

All of this technology is not without its Achilles heels(s). First and foremost, implementing technology-enhanced classrooms requires money, infrastructure, and constant support. Technical and Instructional support needs to be provided for faculty members to make certain that technology is working and put to good instructional use (Strauss, 2002). Instructors are also faced with the dilemma of having students playing the role of stenographer more than listening as they huddle behind the screen of a laptop. Laptops and internet access while providing digital learning content, also allow for more distractions, like web-surfing and chatting during class time. While these aren't insurmountable problems (student engagement and interesting lessons can combat this), they are issues to be aware of.

Additionally, faculty training in pedagogy and effective use of technology takes time and money. Staffing needs in the IT and Media support groups go up as more technology is implemented throughout a classroom. The rapid rate of technology change also presents a constant struggle for universities seeking to standardize their technology-enhanced classrooms. Students are also at greater risk, for the more centralized data storage becomes, the more likely that the theft or loss of a computer could lead to massive loss of information and data. It presents a need for universities and the private sector to deploy even more remote backup and storage solutions for files and information to avoid catastrophic loss in the event of a computer failure or loss.

Conclusions

Technology-enhanced classrooms are becoming more commonplace as the drive to digitize education continues to move forward. While the cost of outfitting these classrooms with the latest video, sound and display hardware and software is very expensive, educational institutions need to also take a serious look at devoting resources to training professors in the pedagogy of teaching and learning in general, and specifically on effective ways of presenting technology-enhanced lessons. While exciting advances in software and hardware that allow for collaboration and pen-based digital inking of documents presents a significant opportunity for change, this is not the first time a new technology was promised to revolutionize the teaching and learning landscape and has failed to deliver (Cable in the Classroom, Computers in every classroom, PDAs as learning devices, to name a few). More research needs to be conducted on the direct impacts these technologies have on student attitudes and performance, and how existing technology can be used to effectively boost learning for all students. A myriad of articles reviewed for this paper were woefully inadequate in terms of research design, sample size, and survey methodology. Very few empirical studies have been undertaken to truly study the effects these new technologies have on teaching and learning. Undoubtedly technology effects learning along multiple domains, and measuring simply performance outcomes would be a grave mistake. However, more rigorous testing of how using different technology-enhanced methodologies enhances the student experience when compared to traditional teaching would provide richer information about how students are learning in these new learning spaces.

Finally, with a rise in digital ink and documents online, a new focus on technology integration, information-management skills for both students and teachers to help them find and utilize resources effectively needs to be emphasized at universities and K-12 institutions.

Having the ability to find, analyze and synthesize information will be come more important as computers can store more and more data. All data is not good data, so being able to traverse this mountain of information will continue to be a critical skill for learners and educators. In concert with this, electronic portfolio demonstrations of knowledge and skills will continue to gain prominence as an alternative authentic assessment as teaching and learning becomes more digitized. We need to keep sight of these larger needs and not get swept away in the urge to pack every classroom with the latest and greatest technological cure to our educational woes.

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