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Effect of Computers on Learning

A Look at Existing Research

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Computers can have either a positive or negative effect on learning, depending on accessibility, application, and integration into the overall learning strategy or curriculum. Computer-based training (CBT) has been proven to be effective in teaching facts and concepts (Williams, 2003). As with any other type of instructional technology, CBT is impacted by the quality of the instructional design, the disposition and learning style of the learner, and validation of learning through interaction with a mentor or coach to provide feedback to the learner. This paper examines recent research into the effect of computers on learning, with a focus on two distinctly different learner domains: K-12 environments with adolescent learners, and corporate training environments with adult learners.

Given that wise choices must be made in choosing the appropriate hardware and software for the classroom, teacher skill and pedagogical approach is what will ultimately determine the success or failure of technology integration into the curriculum (Bitner and Bitner, 2002). Teachers must learn to use technology, and be willing to allow the technology to change their current teaching paradigm. This is not an easy task as change is inherently difficult, and also because there are few good models to emulate for the effective integration of technology into the curriculum. Bitner and Bitner (2002) suggest that there are eight success factors that must be included for successful integration of technology into the classroom:

1. Overcoming fear of change on the part of teachers
2. Training teachers in the basics of computer use
3. Personal productivity skills to free up time for curriculum planning
4. Teaching models for using computers in the classroom

5. Learning models where students search for and discover knowledge
6. Climate that encourages experiment without fear of failure
7. Motivation to endure frustration and turmoil in the change process
8. Support that is onsite and ongoing

Research shows that measurable improvements to writing and research skills of K-12 students occur when they have access to laptop computers in and out of the classroom (Lowther, Ross, & Morrison, 2003). Teachers that received training in curriculum design around the technology, still face the same challenges as do businesses using computers for learning (i.e., monitoring use of the Internet, and dealing with technical problems.) Teachers that were most successful were those who developed student-centric learning models around constructivist principles (e.g., discovery based learning).

In a separate study of 153 schools where social support networks for teachers and sufficient technological infrastructures were in place, Becker and Ravitz (1999) found that teachers' increased use of constructivist teaching practices' was related to their sustained use of computers and their pedagogical exploitation of the Internet. Becker and Ravitz (1999) claim that supportive conditions (e.g., environmental and peer) and the use of technology may cultivate pedagogical beliefs that underlie constructivist practices. In particular, they found that frequent computer and Internet use appear to be related to teachers' (a) being more willing to discuss and seek help on a subject about which they lack expertise and allowing themselves to be taught by students; (b) organizing multiple, simultaneous activities during class time; (c) assigning complex projects for students; (d) giving students greater choice in learning

tasks; and (e) recognizing the initiative that students can take outside class to do high-quality work.

A constructivist theory, intertexuality, refers to the discovery and creation of new ideas that are made through examining relationships between existing ideas and concepts (Taylor and Carpenter, 2002). In the context of art education, this approach allows students to see and experience something differently, allowing them to develop new perspectives from objects they are familiar with. This approach to learning and the study of art can be disconcerting to learners whose experiences are based on linear, organized, and hierarchical exactitudes. Computers offer a means to bridge this gap by providing a learning apparatus that provokes and promotes intertextual thinking. As an example, hypertext provides a common example of using a computer to link and connect programs, applications, and information under the control of the learner. Indeed, the World Wide Web on the Internet is composed of documents that have been written in hypertext markup language (HTML), which defines everything from links to type style and size. Hypertext not only provides the teacher with an organizational tool in development of lessons, but encourages students to see the connections between different subject areas, thereby opening the door to connected learning. No two people will have the exact same responses or connections in their research of a topic because each brings their own meaning and frame of reference, under the constructivist way of thinking.

The use of laptop computers in the classroom is a relatively new phenomenon and is becoming increasingly shaped by the interactions among different interest groups—students, instructors, support staff, administrators, software developers, and publishers. Successful integration of this type of

technology into the classroom will need to meet the needs of each of these groups (Brent, 1999). During the period of a few short years, there have been changes that are both dramatic and far reaching. As a result, it appears inevitable that the classroom will increasingly and irrevocably be populated by computer-literate students with an increasingly sophisticated understanding of computers and tougher standards for acceptable computer programs.

Despite the trend towards increased use of computers in the classroom, however, there is troubling evidence to support the notion that we are not there yet. There are many studies to support the premise that, under the right conditions, integrating technology in the classroom can have a positive impact on learning and teaching in primary and secondary grades including more time on task, higher test scores, lower costs and increased motivation (Norris, Sullivan, Poirot, & Soloway, 2003). Indeed, there are numerous examples of specific classrooms or even schools in which technology has had an impact, though there are few lasting footprints left by the technology. By and large, K-12 schools have not benefited from the same profound changes brought about by computing technologies in other sectors of society including business, manufacturing and scientific research. A snapshot survey was developed for K-12 schools and distributed across geographically dispersed areas of the United States, in an attempt to gauge technology usage and access from the classroom point of view. There were two questions regarding technology usage: 1.) How many minutes per week does a typical student in your class use a computer (but not the Internet) for curricular purposes, and 2.) How many minutes does a typical student in your class spend using the Internet for curricular purposes? The results are summarized in the tables 1 and 2 below.

Table 1. Curricular Use of Non-Internet Computer Technology

Curricular Computer Use	Number of Responses	Percent	Cumulative Percent
None	523	14.4	14.4
< 15 minutes	1,099	30.3	44.7
15–45 minutes	1,364	37.6	82.4
46–90 minutes	427	11.8	94.2
> 90 minutes	212	5.8	100.0
Total	3,625		

Table 2. Curricular Use of the Internet

Curricular Internet Use	Number of Responses	Percent	Cumulative Percent
None	920	25.6	25.6
< 15 minutes	1,493	41.5	67.0
15–45 minutes	959	26.6	93.7
46–90 minutes	177	4.9	98.6
> 90 minutes	51	1.4	100.0
Total	3,600		

To understand the apparent lack of use, two follow-on questions were posed related to access of students to computers: 1.) What is the availability of Internet-connected computers for your students in your classroom, and 2.) What is the availability of an Internet-connected computer lab for your students? The results to the access questions are summarized in tables 3 and 4 below.

Table 3. Summary of Classroom Computer Access

Number of Classroom Computers	Number of Responses	Percent	Cumulative Percent
None	574	15.8	15.8
1	1,724	47.4	63.2
2–5	1,036	28.5	97.1
6–10	140	3.8	95.5
>10	163	4.5	100.0
Total	3,637		

Table 4. Summary of Lab Access

Frequency of Lab Access	Number of Responses	Percent	Cumulative Percent
Never	560	15.8	15.8
Seldom	809	22.8	38.6
1 time/week	994	28.0	66.5
2 times/week	513	14.4	81.0
> 2 times/week	675	19.0	100.0
Total	3,551		

By combining the results from the two access questions, it becomes apparent that K-12 classrooms are still a long way from being "wired". The results would appear to refute the conventional wisdom that adoption of technology into K-12 classrooms is based on individual teacher attitudes. Rather, the results of the survey indicated that teachers' use of technology for curricular purposes is at least in part a function of having access to the technology.

Shifting direction slightly, the remainder of this paper focuses on technology for training and education in the business domain. Businesses are faced with global challenges to provide consistent, just-in-time training for employees in different locations and countries, and to handle staff turnover while ensuring organizational knowledge assets do not leave with employees. There are a limited number of journal articles that deal with the challenges that global operations managers face in achieving consistency of performance, especially in dispersed organizations with small operating units. One such case study looked at Avis of Europe in Spring of 2002 (New, 2003). Over the past ten years, 32% of Fortune 500 companies, including Avis, have made sizable investments in multimedia based training, with estimates in Europe alone approaching $10billion (U.S.) per year. Training typically falls into one of three

categories: processes and procedures, customer service, and sales. The benefits to corporate employees include increased self-confidence of learners, reduced training time, decreased cost, more "active" learning, and easier multilingual delivery. By providing learners with control over the content, they are provided opportunity to generate their own mental maps of problems and situations, which aids in development of skills to solve problems. Despite the potential benefits, many companies struggle with coming up with ways to deploy multimedia training to produce measurable results that are consistent and repeatable.

Many training organizations have backed away from trying to develop all training as Computer-based Training (CBT). A key strength of the computer-based element of any learning process is that it can be effectively used to ensure that when the learners of different experience levels get to instructor-led training, they are all at a similar level of knowledge (Williams, 2003). Hence, the optimum approach is often a "blend" of CBT and instructor-led training, referred to as a blended training solution. Given the variety of instructional, presentation, and distribution methods available, however, can prove to be a serious challenge for the training manager and learner. Ultimately, the key is in understanding the needs of the learners, and not just the delivery methods available. Focusing on the learner should make selecting the most effective instructional, presentation, distribution and assessment methods a much simpler task.

Recognizing the relative strengths in different types of training available to an organization, is invaluable to employees that need to keep their skills up-to-date, while continuously acquiring new ones (Davis, 2000). Training generally best suited for the Internet includes technical training such as learning new a

programming language, process-oriented training, reference information and facts.

Many adult learners have embraced the concept of eLearning for the freedom and flexibility it offers over traditional education. Courses are taken via the Internet and follow a distance education format (Huff, 2003). The primary benefit is that learners may attend classes at their own time and place. Because interaction between student and instructor is not face-to-face, there is less risk of bias due to gender, ethnicity, or physical appearance. Rather, learners are judged entirely on the quality of their assignments. In many on-line courses, the professors are also practitioners, able to provide real-life experience with theoretical knowledge. It may be argued that distance learning students get a better education than their brick-and-mortar campus counterparts, whose professors may be entirely academically trained, without ever having worked in the field in which they teach (Huff, 2003).

The data is inconclusive with regard to the degree of learning value that comes from integrating technology with instruction, whether in K-12 or corporate training. There are ample studies to suggest technology serves as a catalyst for implementing new instructional models for K-12. In corporate training, the value of instructional technology is in maintaining consistent training levels among geographically dispersed employees. Many organizations have jumped on the eLearning bandwagon as a panacea to their learning/training challenges, only to find results that did not improve, or in some cases declined. Successful implementers are those that have taken a measured approach by understanding the needs of the learners and the limitations of the technology.

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