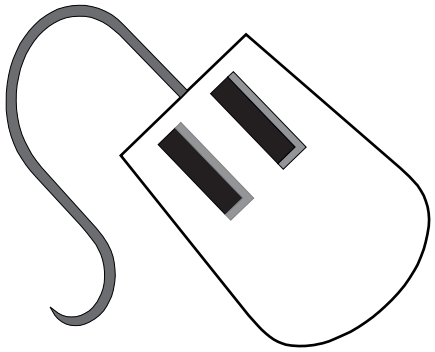

CHAPTER 3
Research and Theory: Do Computers Help Education?

Case Study

Erin is a young 2nd grade teacher in a low-income suburb of Washington D.C. Her class of 23 students contains many learning styles and many reading levels. Four of her students read at a fourth grade level or higher. One of these students, recently diagnosed with ADHD, is showing mood swings due to the dosage of his medication. The dosage his doctor recommended this week has him moving around the classroom with a passion. He is back to his extremely active ways. Last week he was lethargic and fell asleep four times in class. Ten of her students read at close to grade level. Even within this group there are differing learning styles. Some of the kids learn best by hearing her talk, others by acting out stories, while others are very happy to do quiet seatwork. Finally, the remaining students are emergent readers; some are still struggling with their letter recognition. One of these students has shown a lot of potential, but has no support from home. It is known that she has been physically abused, and has some extreme emotional issues. In the computer lab it is important for her to remember these differences. She must plan activities that will allow everyone to work, not expecting everyone to do the same thing, the same way, at the same time.

Technologies such as personal computers, networking, and the Internet have shown great potential to improve, or at least change, the process of education since they were first introduced. Promises have been made as to the productivity gains for teachers and administrators, along with an increase in efficiency of speed and depth of learning by students.

As technology has permeated the business world productivity gains have proven effective in pushing the economy forward. Up to forty percent of the recent growth in the United States' gross domestic product can be attributed to technology increasing productivity (2002, Mann). With these promising results in mind, it makes sense to utilize similar technologies in helping achieve a school's mission. Computers have found their way instructional spaces and into administrative offices and instructional spaces. Finding a school district that is not in some way utilizing information technology is now quite difficult, so determining what the research says about the effectiveness of computers in the practice of education is increasingly important? Recent studies show that the answer

depends on how technology is being used. This chapter will address the research and what these findings say about how computers can be used most effectively.

The Effect of Technology on School Administration

In looking at administrative productivity there is little empirical evidence of gains. In fact, the research is fairly sparse with regard to this research area. Looking to anecdotal evidence (Anecdotal evidence is evidence stemming from a single source, but has not been proven by research) though we are able to find many reports of positive growth in administrative productivity.

A New Zealand governmental study found significant gains in the efficiency of school administration in recording and reporting assessment data along with tracking truancy (1997). A study done in 1998 also found that school administrators and teachers were "using computer tools to streamline record keeping and administrative tasks, thereby helping to free up time for instruction or professional development" (Kosakowski). Freeing up time for instruction and professional development that is otherwise spent on administrative tasks is a huge step forward for educators.

Other positive factors found by Kosakowsi's study include the use of e-mail. This was found to increase productivity for teachers by allowing more efficient communication with colleagues and parents, while also decreasing the inherent isolation that teachers face (1998). Professional development activities, distance education, and assessing educational research and materials were also cited as positives to the use of technology (1998, Kosakowski).

The New Zealand Government study (1997) mentioned distance education in a more student oriented manner stating that it was extremely useful "especially in small, remote and Maori immersion schools where information technology can supplement the expertise of a school's teaching staff with that of teachers located elsewhere."

The Effect of Technology on Student Achievement

The link of educational technology and student achievement is better studied than that of administrative productivity. This is not surprising since the primary mission of schools is to help students learn and to achieve.

Shoffner (2000, 1) explains that, "There is abundant anecdotal evidence of the successful use of technology in the classroom. Pundits say that technology assists in many social aspects of the learning process, including student-centered learning, cooperative learning, and self-regulated learning, self-directedness, as well as all components of motivation, including attention, relevance, confidence, and satisfaction."

Another study, which reported on West Virginia's efforts to increase student achievement in the 1990s revealed that from the years 1991 to 1999 West Virginia's pupil performance went from a rank of 40th to 11th as compared to other states while the per capita income ranking remained constant (Mann, 2002). Mann explains that the most logical explanation for the increase was the push by the state to include technology instruction.

James Kulik conducted a Meta-analysis (a research method that analyzes many other studies already completed) of 500 different research studies and found that the average student who used computer-based instruction scored better on tests of achievement than students without computers (64th percentile versus 50th, respectively) (Schacterth, 1999).

A 1998 meta-analysis of 219 other research studies on educational technology found that students in technology rich environments showed increased achievements in all grades from preschool through college when looking at both regular and special education populations (Schacterth, 1999). The power of a meta-analysis is that this method of research helps to provide a summary of preexisting research and helps to synthesize the current research into one digestible format. The results of a meta-analysis can be much more telling about a big picture than any individual study.

Another 1998 study looked for trends in how technology was used with students and their performance on national tests. It found that those 8th grade student who utilized simulations and higher order thinking skills technologies showed gains of 15 weeks over the norm, while 4th grade students who played learning games performed 3–5 weeks ahead of the norm (Schacterth, 1999). Technology is showing some positive results and is making an impact in education.

Perhaps the best resource for research in the area of educational uses of technology comes from the Center for Applied Research in Educational Technology (CARET; available online at *http://caret.iste.org/*). CARET draws on the most relevant and recent research in education to answer critical questions with regard to technology in education. One question asked is, "How can technology influence student academic performance?" CARET provides summary responses that synthesize the available literature, but the key points are that:

a. Technology improves student performance when the application directly supports the curriculum objectives being assessed.
b. Technology improves performance when the application provides opportunities for student collaboration.
c. Technology improves performance when the application adjusts for student ability and prior experience, and provides feedback to the student and teacher about student performance or progress with the application.
d. Technology improves performance when the application is integrated into the typical instructional day.
e. Technology improves performance when the application provides opportunities for students to design and implement projects that extend the curriculum content being assessed by a particular standardized test.
f. Technology improves performance when used in environments where teachers, the school community, and school and district administrators support the use of technology.

CARET examines other questions beyond just student achievement, so the site is worth a visit. A nice feature is that CARET writes each of their summaries for classroom teachers so the technical jargon of some research is not as apparent in the CARET summaries.

All results were not positive though, the same study that found gains in 8th and 4th grade assessments found that using drill-and-practice software only actually showed a drop in performance compared to the norm (Schacterth, 1999). Drill-and-practice software does have some advantages if used correctly, but this software often gets relegated to busy work with little instructional direction. The Apple Classroom of Tomorrow project had similar findings when it revealed that students who had technology available performed no better on standardized tests measuring vocabulary, reading comprehension, mathematics concepts, and work study (Schacterth, 1999). Clearly, technology is not

going to turn a bad teacher into a good teacher. Technology can be beneficial when used appropriately, but good teaching is still necessary to realize the most positive gains in student achievement and technology can help to facilitate this process.

Implication of the Research on Educational Technology

Knowing that computers have a positive effect on both the business of schools and the attitude and achievement of students is not enough. The rest of this chapter will describe what this research means to the effective use of educational technology in the classroom.

How Do Children Learn?

In order to know how best to use computers in education, having a general idea of how students go about the process of learning is necessary. With years of research in the field of education and child development it might be assumed that the question of how children learn would be settled. Unfortunately for those who work with children, there are differing opinions and these debates continue today. The three major schools of thought are behaviorism, constructivism, and brain theory. For more information on learning theory see Appendix C.

Behaviorism is a theory that looks at learning in terms of behaviors. Behaviorists introduce a condition (stimulus) and uses rewards and punishments to get the learner to complete tasks (responses) correctly. This is called conditioning. The rewards and punishments fall into three categories. Positive Reinforcement is the receiving of something pleasurable for doing something right or not doing something wrong. Negative reinforcement is the taking away of something un-pleasurable for the same reasons. Punishment is the introduction of something un-pleasurable for doing something wrong (White, 1995).

Constructionist theorists believe that we construct much of our own learning, taking what we know of the world, and fitting in the new knowledge. Constructionists feel that learning is the quest to make sense of things, to find a meaning for why things happen. One of the major contributors to constructionist theory is Jean Piaget who described a process of learning where a condition of disequilibrium is set up when a child encounters a piece of new information that does not make sense to her view of the world (schema). To regain the order of the world the child must change her view of the world (accommodate) or change the new information to fit her definitions (accommodate). Constructionists believe it is important for the learners to understand the whole of a task, and all of the parts must be understood with the whole in mind. As teachers it is imperative that the learner's prior knowledge be understood as new learning is taking place (Thurmond, 1999). A classroom where constructivist theories are being implemented will typically appear a bit chaotic and unorganized as students move about freely doing group and individual work. An example of a project that uses constructivism is a WebQuest.

Brain theory is the study of how the brain responds to new information and how it stores and retrieves memories. Understanding how the brain processes information is of great importance to educators. Brain theorists explain that the first stage of memory is "immediate memory." For memories to move into the next stage of memory "working memory" there must be a need for this information to be used for more than a few seconds or more frequently than once. From the working memory information can move to long-term memory so that it can be recalled at a later time. Factors that increase the like-

lihood of information being placed in long-term memory are the ability of the information to help an individual survive, or if it makes a strong emotional impact. In an educational situation factors that seem to help long-term memory are that the information makes sense to the learner and that it is somehow relevant to the learner (Sousa, 2003).

Computers in the Schools

Educational software developers have embraced the theories of behaviorists from the very beginning. Early software, as well as much of what is currently available, tried to help students develop automaticity in basic information through the use of drill-and-practice and educational games. These software packages utilize rewards to reinforce correct answers. Many tutorial programs also utilize the concepts of conditioning to introduce, teach and reinforce basic skills.

Integrated Learning Systems (ILS) utilize many of the same techniques, but are much more extensive. ILS software pretests students, and develops an individualized program of study that can be completed on the computer. These programs usually consist of tutorials, practice, and assessments. These lessons and tests are then recorded by the computer so teachers can monitor the student's progress.

Although there is an abundance of software falling into the behaviorist's camp, the research implies better results with a more constructivist approach. In fact, technology that implements constructivists principles tends to have more positive results.

Constructivism demands a very different model of education. Jonassen explains that, "what is needed in education at all levels is a revolution—not just a change in methodology, but a fundamental revolution in spirit. This revolution will be marked by children who are energized by the personal growth that results from mastering something new rather than complaining about having to complete another assignment or grilling the

LOGO

Seymour Papert, after working with Jean Piaget, co-founded the MIT Artificial Intelligence Laboratory. In his work, Papert created what may be the most famous constructivist technology learning experiment—LOGO Programming Language. With this simple, intuitive programming language students could program the screen "turtle" to move and draw image. Later a robot turtle was added, and when combined with a computer could draw large images on butcher paper on the floor. Papert suggested that this would be a tool to allow students to explore space, shape and color along with critical thinking and problem solving. The MIT lab continued to develop and innovate the LOGO language throughout the 70s and 80s, with one of the most popular innovation being the Lego/LOGO combination. Lego/Logo allowed students to create 3D objects with gears and wheels, and then use the logo language to program the actions of the objects.

Papert and the MIT lab continue to work in the arena of constructivism and educational technology. His most recent book *The Children's Machine: Rethinking School in the Age of the Computer* deals with the uses of computers in the constructivist classroom. For more information on Seymour Papert, The MIT Artificial Intelligence Laboratory, or LOGO, visit the LOGO Foundation website at http://el.media.mit.edu/logo-foundation.

teachers about the contents of the next test; by teachers who are invigorated by the intellectual challenges of their students and who model, coach, and facilitate thinking rather than telling students what is on the next test; and by educational systems that seek to prepare learners for adapting to their environments by being lifelong learners, systems that revile mindless memorization of meaningless trivia" (1996, 257). In explaining this revolution he explains that there should be a computer/student collaboration where students do what humans do best (interpret data, make inferences) while computers do what they do best (store information, sort information, give access to information) (Jonassen, 1996).

Mann (2002) takes this idea a step further claiming that computers should be doing the jobs that teachers should not be bothered with (e.g., record keeping) and should do things that teachers cannot do (e.g., have infinite patience) or do not want to do (e.g., drill children). As technology improves, some of these visions may not appear so out of the norm.

Constructivists believe in the importance of project based, hands-on, problem solving. Education in a constructivist classroom takes more time; it is not a quick lecture, practice, review, and test format. If a traditional classroom teacher lecturing is considered the "sage on the stage," then the teacher in a constructivist classroom would be called the "guide on the side." Constructivists believe in a spiral curriculum where new knowledge is created with the help of earlier experiences.

The Big 6 is an information literacy model developed by Mike Eisenberg and Bob Berkowitz. Students can apply these six steps to any problem-solving situation.

1. Task Definition
2. Information Seeking Strategies
3. Location & Access
4. Use of Information
5. Synthesis
6. Evaluation (1999, Eisenberg)

Lower Elementary students can use an easier version called the Super 3.

For more information on either of these strategies: *http://www.big6.com*

Educational Technology in a constructivist classroom stresses the use of tool and reference software and focuses on the student/computer collaboration, but the constructivist teacher also benefits from technology. A major component in constructivism is giving the student appropriate, and individualized experiences. Databases and spreadsheets help teachers manage what can become a very confusing situation. Constructivism also stresses the use of real world situations and problem solving. One of the major sources for real world data is the Internet. For example, students who are doing work on hurricanes can go the National Oceanic & Atmospheric Administration (NOAA) website to get archived data on past storms or track a current one.

Microworlds *(http://www.microworlds.com/)* are also a major feature in the constructivist's classroom. These microworlds are tiny worlds inside which a student can explore alternatives, test hypotheses, and discover facts that are true about that world (Papert, 1993). Many of these microworlds can be developed on the computer and allow students to explore problems in virtual space. Students must immerse themselves in this world and utilize its rules and laws to solve problems. Many problem-solving models exist, but one that has proven itself for many years and lends itself well to technology is the Big Six developed by Mike Eisenberg and Bob Berkowitz. In utilizing the steps of the Big 6 students are forced to define, brainstorm, search, think, synthesize, and evaluate. In doing this in a problem solving task students are allowed a more authentic learning environment.

A Very Basic Example of a Rubric

Integration Project:

Grading Rubric

General

Grade Level (1) _____

Curricular Strand (1) _____

3 uses of technology (1) _____

Outline:

Clear (1) _____

Time Frame (1) _____

Grade Appropriate (1) _____

Quality (2) _____

Technology Use:

Age Appropriate: (3) _____

Content Appropriate: (3) _____

Reasoning (3) _____

Quality (3) _____

Total: _____

Authentic Assessment (Rubrics)

Authentic assessment is a way of looking at student work in a more real world (authentic) way. This assessment is a key component to the authentic education that is proposed by constructivists.

A Rubric is a tool that is used to better allow a teacher to do authentic assessment. Development of a good rubric for a project allows a teacher to grade a student not only on the final product, but also on the process that was followed to get to that final product.

Rubrics consist of categories and or requirements that are necessary for a completed product. Each of these subdivisions is given a point value. When these point values are totaled, that becomes the final grade. Many teachers give a grading rubric to all students before they begin a project and have them keep track of their own points total. Students tend to like rubrics because they know the expectations upfront.

Examples of Rubrics:

- *http://www.expage.com/page/lebeaurubrics*
- *http://school.discovery.com/schrockguide/assess.html*
- *http://rubistar.4teachers.org/index.php*
- *http://www.teach-nology.com/web_tools/rubrics/*

Linda Starr explains that a good rubric should address all content and objectives, define standards, be easy to understand, allow for self-evaluation, and provide an opportunity for all to succeed (2000).

There are many available resources for developing good rubrics, rubric templates, and rubric examples. Many websites have this information readily available (see box). Striving for these authentic assessments not only to try to quantify an inherently subjective task, but to teach students to self evaluate and assess their own learning and efforts to succeed is important for any good teacher to do.

Summary

Technology has promised positive changes for education for many years. Research has shown positive productivity gains in both school administration and teacher record keeping. Research has also shown a positive effect on student achievement when used appropriately and wishy-washy results when not used appropriately.

Much of the software available to the educational market is behaviorist in nature, such as drill and practice and tutorial packages. Research suggests that this is not the best use of computers in the schools. A more constructivist approach better mirrors the positive research studies. This approach demands real world (authentic) problem solving methods, with the student and computer collaborating toward a common goal.

Required in the process of authentic learning is a method of authentic assessment. One such assessment is rubrics. A well-constructed rubric allows for students to self-access their process and product. Teachers can also benefit from rubrics in allowing them to grade a student's process as well as their product.

Discussion Questions

1. Why do you think some research shows positive results using technology and other research is conflicting?

2. What are some of the basic beliefs of behaviorism?

3. What are the differences between Behaviorism and Constructivism?

4. Explain how information moves from the immediate memory into long-term memory and it's implications for teachers.

5. What types of software exemplify the behaviorist's theories? What types exemplify the constructionist's philosophies?

6. What is authentic assessment and how is it best used in the classroom?

Key Terms

Accommodation: The process, as described by Piaget, in which the learner's world-view (schema) is changed to allow a new piece of information to fit.

Assimilation: The process, as described by Piaget, in which a new piece of information is manipulated to allow it to fit into the learner's world-view (schema).

Behaviorism: a group of theories that hold the concept that learning is based on stimulus and response, that rewards can reinforce behaviors, and that complex tasks are best learned by mastering a set of sequenced simple tasks.

Conditioning: a behaviorist concept for learning, in which a stimulus creates a desired response.

Constructionism: A group of theories that are based on the belief that children are active participants in the learning process. Constructionists believe that learning comes from a desire to find meaning in the world. They believe that learning should be student directed learning, with an individualized curriculum, and the teacher serving as a facilitator.

Disequilibrium: a state of confusion, as described by Piaget, that is present before learning takes place. It is created when a learner encounters a piece of information that does not fit into their world view (schema).

Facilitator: a person who helps someone achieve a goal. In an educational setting this refers to where a teacher helps a student learn instead of a direct instruction model.

Meta-Analysis: a research study that compares the findings of many earlier studies.

Negative reinforcement: As described by behaviorists, this is a type of reward where an unpleasant situation is altered for the better in response to a correct action.

Operant conditioning: A type of training, as described by B.F. Skinner, in which a behavior is learned through a series of rewards and punishments.

Positive reinforcement: As described by behaviorists, this is a type of reward where a positive situation is created in response to a correct action.

Punishment: As described by behaviorists, this is a situation in which an unpleasant stimulus is added or a pleasant stimulus is taken away because of a wrong action.

Stimulus/response: A process, described by behaviorists, in which a response is learned by repeated exposure to positive or negative stimulus.

Extension

1. Find research to support using technology your subject area. You can start with the online databases available from your school's library. You might explore *http://caret.iste.org/* as well.
2. Which set of theories do you think will play the greatest role with you as a teacher? Why?
3. Think about a lesson using the problem solving method. How can the big 6 help? Develop a rubric for assessment,
4. Compare and contrast the workings of the human brain and a computer.
5. Concentrate on some of your earliest memories. Looking at the brain research, why do you think that these memories were places so permanently into your long-term memory?

Websites

Funderstanding Learning Theory
http://www.funderstanding.com

Theorists of Behaviorism
http://tiger.coe.missouri.edu/~t377/btheorists.html

Constructivism and Constructionism
http://userwww.sfsu.edu/~foreman/itec800/finalprojects/annmariethurmond/home.html

Brain Research
http://www.novusresearch.com/research/memorybrain.html

Neuroscience for Kids
http://faculty.washington.edu/chudler/neurok.html

LOGO Foundation
http://el.media.mit.edu/logo-foundation

References

Eisenberg, M. & Berkowitz, R. (1999). Teaching Information and Technology Skills: The Big 6. Worthington, OH: Linwood Publishing, Inc.

Jonassen, D. (1996). Computers in the Classroom: Mindtools for Critical Thinking. Englewood Cliffs, NJ: Prentice Hall.

Kosakowski, J. (1998). The Benefits of Information Technology Eric Digest EDO-IR-98-04.

Mann, D. (2002). The Productivity of learning technologies: a school and learning policy review; it's time to sing the productivity praises of our educational technologies. Technos: Quarterly for Education and Technology. Retrieved 3/17/04 from *http://www.looksmart.com*

Papert, S. (1993). The Children's Machine: Rethinking School in the Age of the Computer. New York, NY: HarperCollins Publishers.

Schacterth, J. (1999). The Impact of Educational Technology on Student Achievement. Santa Monica, CA: Milken Family Foundation.

Shoffner, M. et al. (2000) Implications of New And Emerging Technologies for Learning and Cognition. *Journal of Electronic Publishing,* 6(1).

Sousa, D. (2003). How the Gifted Brain Learns. Thousand Oaks, CA: Corwin Press, Inc.

Starr, L. (2000). Creating Rubrics: Tools You Can Use. Education World.

Thurmond, A. (1999) Constructivism and Constructionism. Retrieved 3/6/04 from *http://userwww.sfsu.edu/~foreman/itec800/finalprojects/annmariethurmond/home.html*

Use of Information Technology in Schools. (1997) Education Review Office (Te Tari Arotake Matauranga), New Zealand. Retrieved 6/10/04 from *http://www.ero.govt.nz/*

Warlick, D. (1999). Raw Materials for the Mind: Teaching & Learning in Information & Technology Rich Schools. Raleigh, NC: The Landmark Project.

White, A. (1995) Theorists of Behaviorism. Retrieved 3/6/04 from *http://tiger.coe.missouri.edu/~t377/btheorists.html*