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The Impact of Technology on Special Education Students

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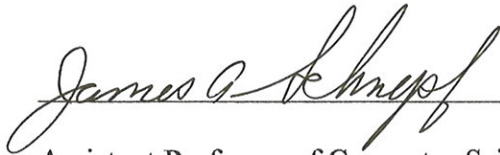
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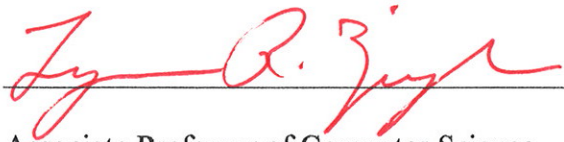
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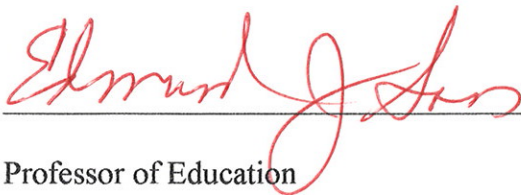
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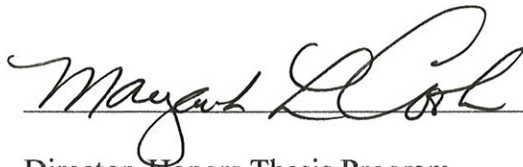
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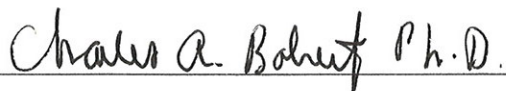
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I. Introduction

Two years ago I witnessed a strange occurrence. I was visiting my father's classroom and there were students there. What is so strange about that you might be asking. The strange thing was that it was a holiday; school was not in session. I began to question my father about this, and he verified that students were showing up before school, after school, during passing time, on weekends, and even on vacations. Students who never came to class were coming for his. My father had created a new type of classroom, a classroom based around technology. I was really intrigued by the improved attendance of his students and thought it might be interesting to study this group to see if this approach was yielding any measurable improvement in these students.

This paper will explore the effect that technology has in education and look specifically at how technology has impacted one classroom. A survey of the literature will present an overview of the state of technology in education as well as show some of the impact that certain technologies are having in various classrooms. This will be followed by a study of one inventive classroom whose focus is technology. Students in my father's class work in groups and independently to repair old and damaged computers, network these repaired computers, create and analyze websites, and use multimedia products to create presentations.

My father is a special education teacher; he works with students that are labeled with emotional behavior disorder and/or learning disabilities. The National Center For Education Statistics' *Digest of Education Statistics 1997* states that from 1995-96, 5,573,350 children were served under the Individuals with Disabilities Education Act and Chapter 1 of the Education Consolidation and Improvement Act. There are approximately

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5.5 million students with some kind of learning disability. This figure represents a significant portion of our children and begs the question: how can these students best be served by our education system?

II. Research

1. The Technological Revolution

Almost four hundred years ago, human society changed dramatically; we experienced the agricultural revolution and the face of society was drastically changed. A short hundred years later we experienced another revolution as we moved from agriculture to industry; we entered the industrial revolution. Once again society shifted. We find ourselves now in another revolution, and like its predecessors, it too will completely rework our society. We are in the technological revolution. Also know as the information revolution the changes that we are witnessing will forever change how humans work, play and learn. The information revolution will forever change the way we teach and acquire knowledge. It will change our schools and us.

A relatively new area that is emerging from this revolution is Education Technology. What it is and what it represents is evolving with the rest of our society. Many think that it is about teaching computers, but at its heart it is about changing how we teach. This section will look at a number of articles on the subject, and in particular investigates two issues: how our schools themselves will evolve and how our approach to and method of teaching will change.

Schools are finding their way onto the information superhighway; they are connecting to the Internet. In fact, President Clinton lists connecting schools to the

Internet as the second of four pillars of his Technology Literacy Challenge. The report states:

> Classrooms will be connected to one another and to the outside world. Connections to local area networks (LANs) and the Internet turn computers into versatile and powerful learning tools. Access to these networks introduces students and teachers to people, places, and ideas from around the world to which they might otherwise not be exposed.

On November 16, Minnesota held its first "Net Day." On this day, thousands of volunteers installed cable in many Minnesota schools. In conjunction with this, many professionals have and are donating their time and expertise to help more schools gain Internet access and have school or district wide networks.

Many feel that networks are one of the key technologies facing schools as they adapt to the changing face of education. In his article entitled "Technetronic education: Answers on the Cultural Horizon," Larry Press says "I feel two technologies, computer networks and portable, penbased computers, will have a profound impact on education" (p. 17). Press mentions two network projects that have had impact on school age children in this country called K12Net and National Geographic's Kids Network. The most interesting part of Press' article is about an innovative approach in Chile. In 1992, Pedro Hepp and his colleagues began a five year project to develop and evaluate an elementary school network. They are working with a group of 100 schools (targeted mostly in urban and rural low income areas). The network uses a Latin plaza metaphor for an interface, and allows email and usenet style postings as well as other relevant technologies.

Dick Ruopp and Shahaf Gal discuss another application of networks called LabNet. LabNet sprang out of three threads: to use science to enhance science learning, to build a supportive community among LabNet teachers, and to promote new technology in science learning. The main goal of LabNet is to provide a method for teachers to exchange ideas. Teachers can participate to the level they are comfortable, they can use LabNet for email or they can post to the Forum (usenet style) or both.

One innovative use of this network was by Bruce Keyzer, a physics teacher in Illinois. Two of Keyzer's students wanted to estimate the circumference of the earth using the angle of the sun's rays at local noon along with the time of local noon. Keyzer posted to the Forum looking for teachers from other areas that were interested in helping. By the time he had chosen a date to coordinate the effort, thirteen other teachers had volunteered their help.

It is not only the wiring that will change in new schools. Robert Pearlman sees five elements of school practice and organization that will change: school organization, curriculum, assessment and accountability, technology, and learning environments. The traditional class room itself will change dramatically as these issues are addressed. Pearlman points to two examples, the South Point Elementary in Dade County Florida, and our own Saturn School of Tomorrow in St. Paul. Both schools take an innovative approach where the traditional classroom is no where to be seen. According to Pearlman's account, the Saturn School "looks like a series of work rooms, work spaces, work areas, specialty work rooms, offices and discussion rooms" (p. 48). The school also has a lego robotics room, a writing and desktop publishing lab, and spaces through out the school for group work. Of course, the school is completely connected by a LAN.

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Pearlman is involved with a project to design the CoNECT School (Cooperative Networked Educational Community for Tomorrow). He lists three key components for this new school: a restructured school community revolving around student clusters, a project based curriculum supported by seminars, and an integrated communication network.

As our schools change, so too will the way we teach. Technology has been adopted to some degree by almost every institution in this country; it is the level of adoption that is important to note. William F. Massy of the Jackson Hole Higher Education Group at Stanford lists three stages of information technology adoption: 1. productivity assistance (conventional tasks done faster and better, i.e., word processing), 2. enrichment add-ins (new methods, using multimedia presentations, VAX notes, etc.) and the final stage 3. the stimulation and enabling of a paradigm shift (a new method of learning and teaching).

Virtually everyone is using computers and technology to enhance productivity. According to Massy, this phase is where most institutions are now. Almost all universities and most high schools offer computer labs with word processing, database, and presentation software. A few schools are beginning to incorporate technology into their classroom; for instance, my father has used a current events questionnaire and discussion tool that is created by CNN and put out through their web site.

To make the jump to the third stage, a paradigm shift is required. Massy spoke of one university in New York that has completely changed the way it teaches. The school began to look at its methods after losing increasingly higher numbers of first year students especially in the sciences. This university used two approaches to technology integration in the classroom: the studio approach and the modular.

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The studio approach began in the sciences, specifically physics. In this discipline, the entire lecture lab format was changed. Instead of going to a class three days a week for lecture and then having one or two labs in conjunction, they combined the two. Along with this change, they restructured the classroom itself, using a large auditorium of networked computers, with a teacher station at the head along with an overhead projector. The instructor can look at and project anyone's computer screen for the group and can also take over and control any workstation. Another change was in the laboratory itself, no longer were actual experiments done, but virtual simulations were used instead. A typical class would consist of a lecture with labs interspersed. The strength of this is obvious: you can immediately show the experiment that goes with the lecture. This approach also allowed the students to work at their own pace and thoroughly understand the topic before moving on.

This approach was so successful that it moved into the other sciences as well. Chemistry and mathematics are also taught in the same manner. However, this method did not stay only in the sciences, it moved to the humanities though it did change to meet the different needs of the subject area. For this arena, the modular approach was developed. Here, students pass through modules as they learn at their own pace. The class starts in the typical lecture format, but after a short period moves to smaller interactive sessions run by the students and mentors or teachers assistants. This is where the bulk of the course work is done. Students that need special help meet with the professor as needed. Once the students pass through a gateway of some type, some form of learning objective, they move back to the professor for seminars that seek to find the implications and interpretations of the subject area.

Alan C. Kay tempers the discussion a bit in his article "Computers, Networks and Education." He states that the media is not the content much in the way that the piano is not the music. Computers can play a huge role in education, but it must be done properly. Kay continues by saying that the mere presence of the technology is not enough, the teachers must embrace and teach with the computers. Computers are capable of amplifying learning, but they must be used wisely. Kay goes on to describe a project he and colleagues worked on in the Los Angeles area on integrating technology. Computers were used to help a group of students design and build a mock city. The computers allowed the students to study the effects of smog build up and look at ways to alleviate pollution in their city. Unlike Massy, Kay seems to keep the technology within the current educational paradigm; he does not call for such a large shift.

As the way we teach changes, the work of our students' will change also. Elliot Soloway writes about a program that he and his colleagues are developing at the University of Michigan (Ann Arbor) called MediaText. Computer technology allows for a variety of media to be used by a student. No longer are pupils limited to pen and paper, now they can use sound and video and other multimedia elements in their writing. MediaText simplifies the creation of multimedia documents. Soloway sees the next step as being interactive documents stating that as technology becomes more universal and integrated (and as prices drop) millions of parents will buy their children small hand held computers to use for educational purposes. This force will change the way students write as well as they are able to create and work with truly interactive documents.

2. Technology Integration Statistics

Educational Testing Service published a report entitled "Computers and Classrooms - The Status of Technology in U.S. Schools." The report is an analysis of series of data collected about the use and proliferation of technology in U.S. schools. The report identifies the differences in technology access from state to state and, where available, breaks access down by race and gender.

According to Coley, Cradler, and Engel, 98 percent of all schools own computers with the average student-to-computer ratio standing at 11 to 1 though the range in states is from 6 to 1 in Florida to 16 to 1 in Louisiana (3). This statistic alone shows that computers are fairly ubiquitous within a school district. However, this does not tell us anything about the quality of those computers. Having a lab full of 286s does not mean the same as a lab full of Pentium IIs. In fact, the first pillar of President Clinton's Technology Literacy Challenge states:

> Modern computers and learning devices will be accessible to every student. To make technology a viable instructional tool requires schools to have enough computers to provide full, easy access for all students, including students with disabilities. Although the national student-to-computer ratio is currently 11:1, the ratio of students to powerful multimedia computers is only 35:1.56. In contrast, many studies suggest that full, easy access, requires a ratio of about five students to each multimedia computer.

It is not sufficient to have a lab of outdated computers. We must be willing to fund the cost of maintaining labs with the technology that best serves our students.

Computers are by far the most widely used technology in schools, though just slightly ahead of VCRs. Interestingly enough, multimedia computers (defined as high-speed computers with large memory and storage as well as sound, graphics, and video components) are next on the list at 85 percent. However, as the President's report states, there are still not enough multimedia computers per student in this nation. While the average ratio of students-to-computers is 11 to 1, this ratio drops to 35 to 1.56 for multimedia computers (Coley, Cradler, and Engel 14). Following multimedia computers, is access to the Internet. Currently, 64 percent of our nation's schools have access to the Internet. However, this study does not define access. One computer in the media center is indeed access but extremely limited access. Students dialing in with a 14.4 modem certainly are at a large disadvantage to those with a dedicated T1 connection.

Technology has made some inroads into schools, but how are students using it? According to Coley, Cradler, and Engel, children in grades four mostly use computers to play games (87 percent) and to learn things (82 percent). At grade eight, we see the same percentage using computers to play games, but now, 82 percent are using computers to write stories or papers (27). By grade 11, we see writing with the computer as the number one use with 87 percent using them for such purposes with gaming holding a strong second with 77 percent. Along with this data, we look at how often kids are using computers for schoolwork. Not surprisingly, as children progress from grade 4 to grade 11, we see a steady increase in those who use computers almost daily and a decrease in those that never use computers for schoolwork (Coley, Cradler, and Engel 28). Interestingly though, the statistics for those who use the computers once or twice a week

is actually highest amongst fourth-graders, dropping in eighth grade, but then rebounding slightly for eleventh-graders.

3. Technology use in Schools

The idea of bringing technology into the classroom is not a new idea. In fact, early research on computer-based instruction showed "students demonstrating increased learning performances despite limitations of the systems and software" (Howell 58). The model has shifted from using old mainframe systems to the personal computers that we know today, but computers in education have been around since the 1960s. On a federal note, for more than two decades, the Office of Special Education Programs has been committed to using technology to help people with disabilities (Hauser and Malouf 504). A 1988 report from the Office of Technology Assessment concluded that the government must take a more active role in technology if it was to fulfill its potential in education (Hauser and Malouf 504).

Throughout the decades, there have been three main functions of computers within an educational setting: 1) present information and query/evaluate students {the tutor mode}, 2) increase quantity and quality of student output {the tool mode}, 3) facilitating learning of a programming language {tutee mode} (Howell 58). Most often, computers are used in a drill and practice and to teach programming languages. We have seen how technology has raised the expectation of teachers on the esthetic quality of our work. No longer are spelling mistakes and whiteout accepted as a finished product. Technology has been and is being used in classrooms, but what is the impact on students with special needs?

Research has shown both positive and negative impacts of learning with computers. It is widely held that technology has proven more efficient. Currently, most computer use is oriented to application software (i.e., word processing, spreadsheets, etc.) while we find a drop in the use of computers for simple drill and practice tutorials. Interestingly enough, research has shown that computers often result in more group-oriented work. This is consistent with what my father has seen in his students. They are working in groups to create web sites, multimedia documents, and repair hardware.

However, there are less positive impacts of technology. Studies have shown that programs like *Where in the World is Carmen San Diego* show no greater rate of retention than more traditional methods of teaching geography. Often times, students shift their goals towards things that they understand. However, these goals often do not match up with what the teacher is trying to accomplish. Critics point out that computers are often introduced in ways that do not mesh well with traditional routines of classroom learning.

Despite the negatives, technology does show some benefits for students with mild disabilities. Some studies show that software can have benefits in many content areas including mathematics, word recognition, health education, and problem-solving skills. Another exciting area is interactive multimedia (i.e., interactive videodisk and hypermedia). Hypermedia has been shown to improve the mathematics problem solving skills of students with learning disabilities (Babbitt and Miller).

There is an abundance of research in the field about technology in schools though little of what I have reviewed looks into the impact that technology has on students. Much of the research that I have surveyed deals with teacher training and the use of hypermedia. I am aware of no classrooms that are similar to those I am studying, and I

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found no research into the impact of this type of technology as it applies to special education students. Several studies have been done that survey special education administrators and teachers including one in California that measured the application and use of technology within special education programs, but it did not look at any specific outcome of the use of that technology (Howell). This study seeks to quantify the impact of the use of certain technologies within a special education classroom.

Some studies show that technology has the ability to help special education students. An article by Carol S. Holzberg gives a brief survey of several successful programs that integrated technology into a special education setting. Holzberg describes one classroom that used the Internet extensively quoting a teacher who said, "The project broke down classroom barriers" (19). Also of note, these students' reading levels improved though no specifics are given as to how much and if this effect was seen throughout all of the students. Holzberg goes on to describe another classroom where the students used multimedia CD-ROMs along with a video camera to add video, audio, and sound to their research papers on insects and animals found in a local woods. At the start of the program, all of the students were reading below their grade level, but by the end some of their reading test scores went up two grade levels (Holzberg 20). These same students went on to serve students and teachers in a technical support manner. The main downfall of Holzberg's article is that it relies mostly on teacher reaction; she does not employ hard facts. This study seeks quantify what teachers are saying about the impact of technology in the educational lives of students.

One very promising study indicates a positive impact of Internet utilization. Sari Follansbee, Bob Hughes, Bart Pisha, and Skip Stahl published an article entitled "Can

Online Communication Improve Student Performance? Results of a Controlled Study."

The study was conducted in seven major cities during the 1995-96 school year. Each city

had two schools in the experimental classes (classes that used online resources) and two

control classes (classes that did not use online resources). Students were in fourth and

sixth grade. It should be noted that unlike the classroom studied here, the students

studied were not special education students. Participating districts were given:

"curriculum supports for a unit on civil rights, online accounts (Scholastic Network housed

on America Online with access to the Internet), training, and online mentors as well as the

opportunity to experiment with implementing online use in the classroom." (Follansbee et

al. 16). Both the experimental and control groups were given the same civil rights unit.

Teachers in the control group used traditional methods while those in the experimental

group utilized online resources.

Students in both groups completed a final project that was scored by an external

evaluator. The evaluator had no prior involvement with the study and had no investment

in the results. According to the Follansbee et al.: "mean scores for students in the

experimental group were higher than mean scores in the control group" (20). Follansbee

et al. goes on to state "This offers evidence that using online resources can help students

become independent, critical thinkers, able to find information, organize and evaluate it,

and then effectively express their new knowledge in compelling ways." (24). Also of

interest are teacher comments made during follow-up interview sessions. Teachers

commented that "[students] couldn't wait to come to the classroom" (22). This comment

mirrors the observations that I have made during my study of my father's classroom: these

students want to be there.

III. The Study

This study seeks to prove that basing a classroom on hardware repair and web development can improve the critical thinking skills of students labeled with emotional behavioral disorder or as learning disabled (EBD or LD). After participating in this technology class, it is expected that the special education students studied will show a higher level of improvement than the control groups when measured with an assessment tool.

1. The Technology Class

The class I am studying is unique in its approach to learning. There are three major components to the classroom experience of the students involved in the technology class: computer repair, web development, and desktop publishing.

The class started with the notion of generating more technology within the special education department. Since the school could not afford brand new computers, the teacher decided to try and fix old computers. Students solicit local businesses and community members to donate computers that are largely older 386 and 486 DOS based PCs. The students then make any repairs necessary to get the machine to function. Through the process of trouble shooting these computers, the teacher stresses problem solving techniques and working with other students in determining what is wrong with a given machine. Written skills are emphasized in letters seeking donations as well as thanking those that have donated their time and hardware.

After several months of work, the students in the class have managed to create a local area network in their classroom. Working with donated machines and Windows 95, the students created a network with three computers. The computers share files, printers,

and a common Internet connection. There are more Internet connections in this classroom than in any other in the school due to the work of these students.

I happened to be present when the students finally realized their goal of creating a local area network. The look of accomplishment on their faces was really uplifting. I can only imagine what this kind of success must do for their self-esteem. These are students with little to no professional guidance; they are learning how to work with these devices as they go. Little of the hardware or software that they are working with comes with complete manuals; they are often restricted to what they can find on the Internet and in other resources. They do not have a technology expert on call; they must learn while they work. While this sometimes makes the process longer, I think that it is a richer learning experience for the students.

An outgrowth of the increased technology integration was the desire of my father to introduce the students to the information on the Internet. The teacher decided to have the students work on producing their own homepages. Students explore the Internet, looking for examples of good web design that they then incorporate into their own local web sites. The students' are in the process of entering their work in a web development contest. Through the work with the Internet, students work on written skills as well as developing the ability to analyze other's work.

After working with the web development, the group began exploring desktop publishing. A guest speaker demonstrated several common desktop publishing software titles, and the students began producing their own work. Using a digital camera, scanners, and the Internet, the students design and distribute a newsletter, fliers, and

other similar items. The district technology person enlisted the students to help create a slide show presentation for a recent parent open house.

2. Subjects

Three groups from a large public high school in the suburbs of Minnesota were studied to determine what impact one teacher's use of technology is having on a group of special education students in relation to another group of similar special education students as well as a group of mainstream students within the high school. The study group is made up of nine special education students that are enrolled in a technology class, the first control group is made up of ten similar special education students (in relation to the study group), and a third group of fourteen mainstream students. This study is being done with the cooperation of the school's principal and the special education department. The special education department of the high school involved chose the control groups. The special education control group was chosen to match the makeup of the experimental group (i.e., a similar number of EBD/LD students). The parents of the students involved in the study received a letter indicating that their child was chosen to participate, described the study to them, and also gave them instructions for removing their student from the study. One parent asked for more information and, after talking with the technology teacher, requested that her child be placed into the technology class.

3. Procedure

Before the study began, a letter was drafted and sent to all the parents of the students involved explaining what the study was about and why it was taking place. The parents were asked to contact my father with any and all questions. Parents were given

the option of removing their children if they so desired. After requesting the appropriate number of tests and score sheets from California Academic Press, the students were randomly assigned an identification number.

The students were measured over the course of one semester (starting in late September and running until mid January). I expected that the students in the experimental group would show a greater improvement as shown by the California Measure of Mental Motivation (CM-3) over the course of the study than those in the control groups. I am particularly interested in the comparison between the study group and the mainstream students. After the initial round of testing, I found that I had more problems with the mainstream students than either group of special education students. Within the mainstream group, two students stopped answering questions after the eighth test item, several incorrectly filled out their data section of the answer sheet, and one answered the last thirty questions with the same answer. I observed no such problems with the special education students.

4. Assessment Tool

To determine what impact the technology instruction is having on the students, I have chosen the California Measure of Mental Motivation (CM-3) written by C.A.F. Giancarlo and P.A. Facione and distributed by The California Academic Press. The CM-3 is a new instrument but is designed to be a children's version of the California Critical Thinking Disposition Inventory (Facione & Facione, 1992). The CM-3 was developed to measure the following constructs: Truthseeking, Open-mindedness, Analyticity, Systematicity, CT Self-Confidence, Inquisitiveness, Maturity of Judgment, Creativity, Cognitive Engagement, and Mental Motivation. As of now, there are 100 items on the

CM-3, all of them statements such as "I love learning new things" and "I am known for being organized when I work on a problem," and children are asked to respond to each statement as to whether they Agree or Disagree. The CM-3 is designed for children in elementary, middle, and high school grades, and is most ideally used by students with at least a fourth-grade reading level. Because the instrument is new and currently being validated, there is no detailed reliability or validity information though the CM-3 is being used at the present time with the help of educators at different sites around the country. (Giancarlo, Carol Ann F. email to the author 22 July 1997).

Originally, I had intended to utilize two other tests: the California Critical Thinking Skills Test and the California Critical Thinking Dispositions Inventory. Richard Wielkiewicz, associate professor of psychology at the College of Saint Benedict and St. John's University, recommended these tests. However, after consulting with the California Academic Press, it was recommended that I use the CM-3. The California Critical Thinking Skills Test and the California Critical Thinking Dispositions Inventory are written for students in college while the CM-3 is written for students in grade school and high school. It was felt that this test would be more appropriate for the students in the study. The CM-3 was distributed and scored free of cost, which was a factor in choosing to use it.

The CM-3 measures seven factors: mastery orientation, mental engagement, mental discipline, composure, creativity, truthseeking, and an overall score. The authors define the factors as follows. The definitions of the factors were obtained in a personal correspondence with Carol Ann Giancarlo.

Table 1: CM-3 Factors

• Mastery Orientation – a person scoring high in mastery orientation strives to learn for learning sake; they value the learning process as a means to accomplish mastery over a task. These individuals are eager to engage in challenging activities. A general inquisitiveness guides their interests and activities (11 items, $\alpha = 0.74$).
• Mental Engagement – Individuals scoring high in mental engagement are motivated to use their thinking skills. They are positively disposed toward critical thinking. These individuals are engaged in their surroundings, they enjoy thinking about and interacting with others potentially varying viewpoints. (11 items, $\alpha = 0.69$).
• Mental Discipline – The person scoring high in mental discipline is focused, task oriented, organized and clear-headed. When engaged in a mental activity they tend to be focused in their attention and persistent. Those individuals scoring low on this scale express a viewpoint that is best characterized as cognitive apathy (12 items $\alpha = 0.70$).
• Composure – The person scoring high in composure is intellectually poised, diligent, and confident in their problem-solving skills. Others look to this person to determine if reasonable solutions to problems have been reached (9 items $\alpha = 0.64$).
• Creativity – The individual scoring high in creativity enjoy artistic pursuits such as drawing and building. They believe creativity to be one of their strong points (5 items $\alpha = 0.62$).
• Truthseeking – The Truthseeking factor of the CM-3 measures intellectual honesty, the courageous desire for the best knowledge in any situation, their inclination to ask challenging questions and to follow the reasons and evidence wherever they lead (7 items $\alpha = 0.56$).
• CM-3 Overall Score – The CM-3 Overall scale represents the sum scores on the above six scales. This score represents the individual's overall cognitive engagement and mental motivation toward thinking (55 items $\alpha = 0.83$).

5. Results

All scores on the six factors are on a 30-point scale. Scores ranging from 0 to 10 points represent individuals who are negatively disposed toward the factor. Scores ranging from 11 to 20 points represent persons who are ambivalent toward the

disposition. Scores ranging from 21 to 30 represent individuals disposed toward the factor (Giancarlo, Carol Ann F. letter to the author 24 March 1998).

Initially, the study consisted of 33 students, 9 in the experimental group, 10 in the special education control group, and 14 in the mainstream control group. Five students in the control group were not enrolled in the technology class at the time of the posttest having either left the school district or being unable to fit the class into their schedules. Three factors account for the remaining loss of participants: 1) student left the school district, 2) the student's answer sheet was not returned, 3) California Academic Press was unable to score the answer sheet.

Please note, in the following graphs and charts, Experimental refers to the students in the technology classroom, Control Group 1 refers to the special education control group, and Control Group 2 refers to the mainstream control group.
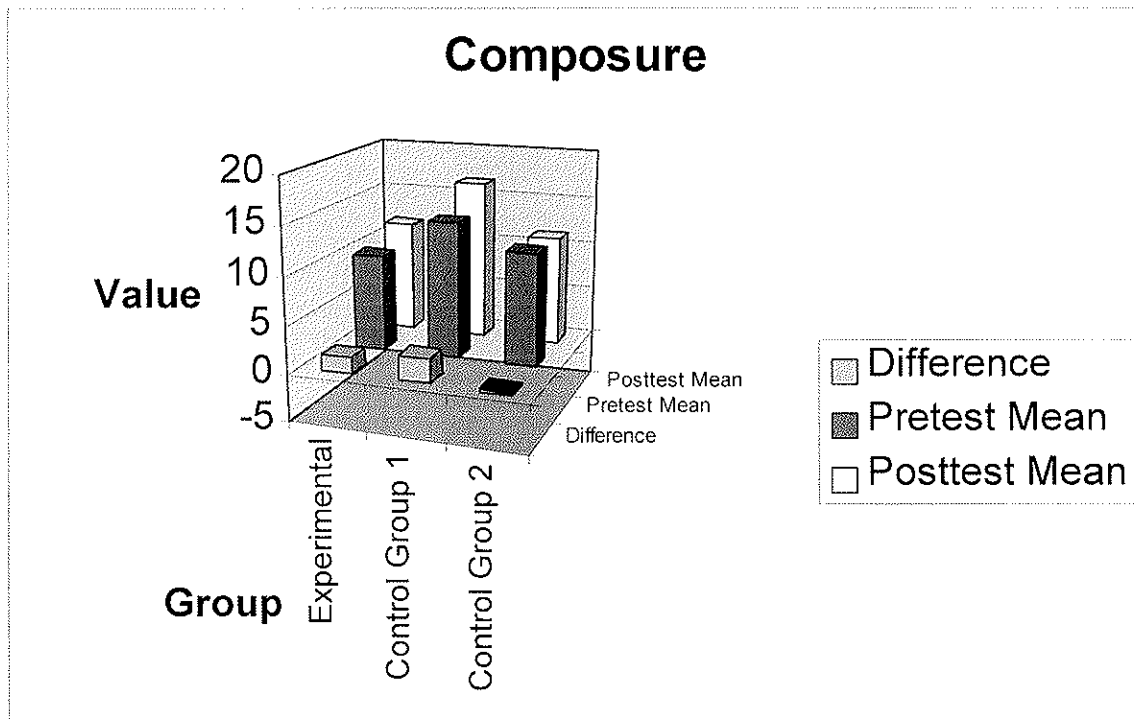
Mastery Orientation

Group	Pretest Mean	Posttest Mean	Difference
Experimental	19.09	20.4525	1.3625
Control Group 1	15.6833	15.91	0.2267
Control Group 2	14.545	18.6367	4.0917
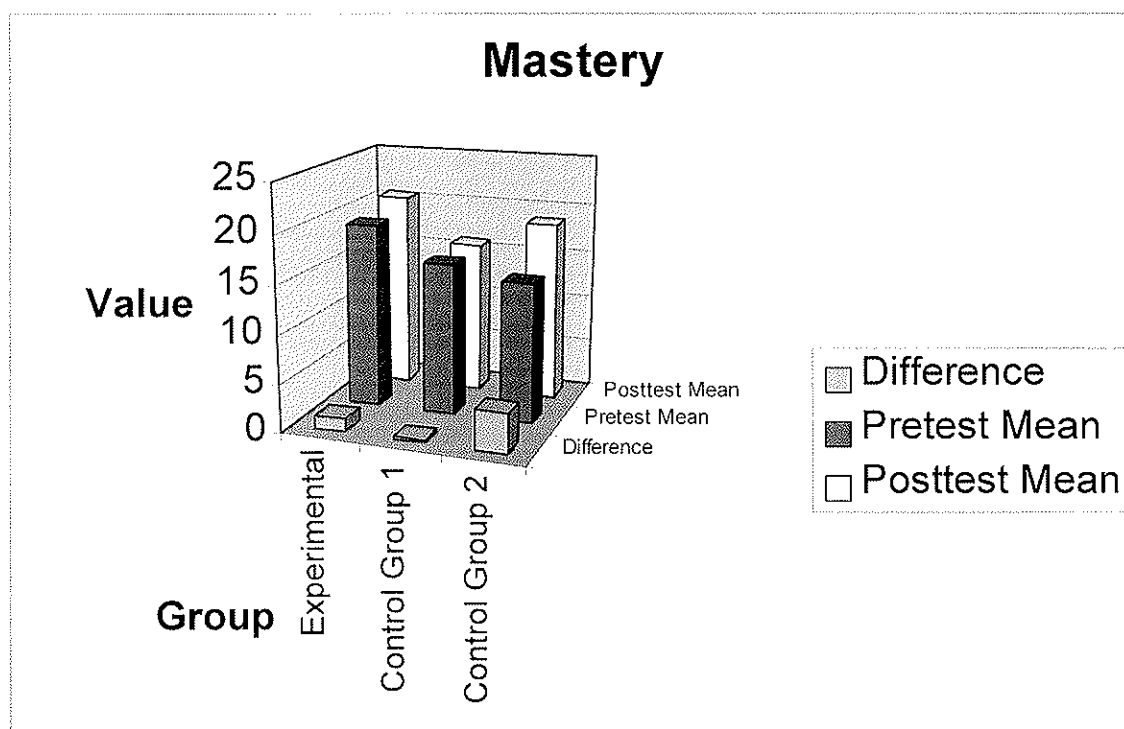
Composure

Group	Pretest Mean	Posttest Mean	Difference
Experimental	9.9975	11.6675	1.67
Control Group 1	14.1683	16.6667	2.4983
Control Group 2	11.6683	11.3883	-0.28

Creativity

Group	Pretest Mean	Posttest Mean	Difference
Experimental	21	16.5	-4.5
Control Group 1	21.5	24	2.5
Control Group 2	16	19	3
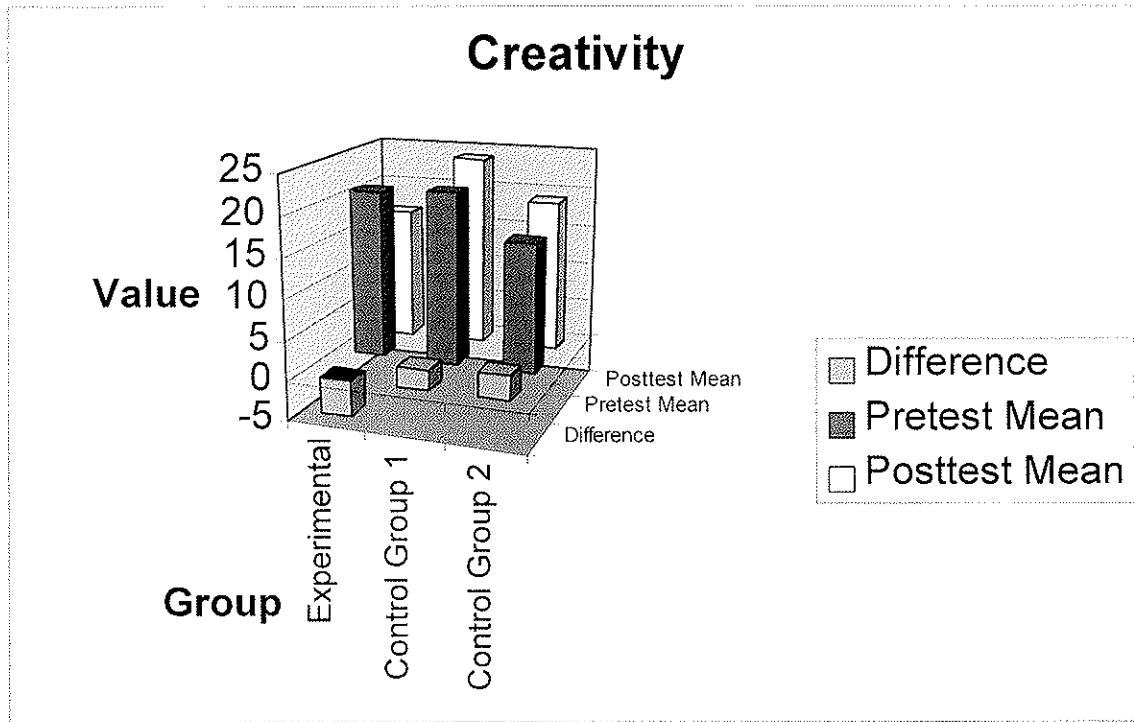
Discipline

Group	Pretest Mean	Posttest Mean	Difference
Experimental	20	16.875	-3.125
Control Group 1	17.0833	18.3333	1.25
Control Group 2	19.1667	17.9167	-1.25
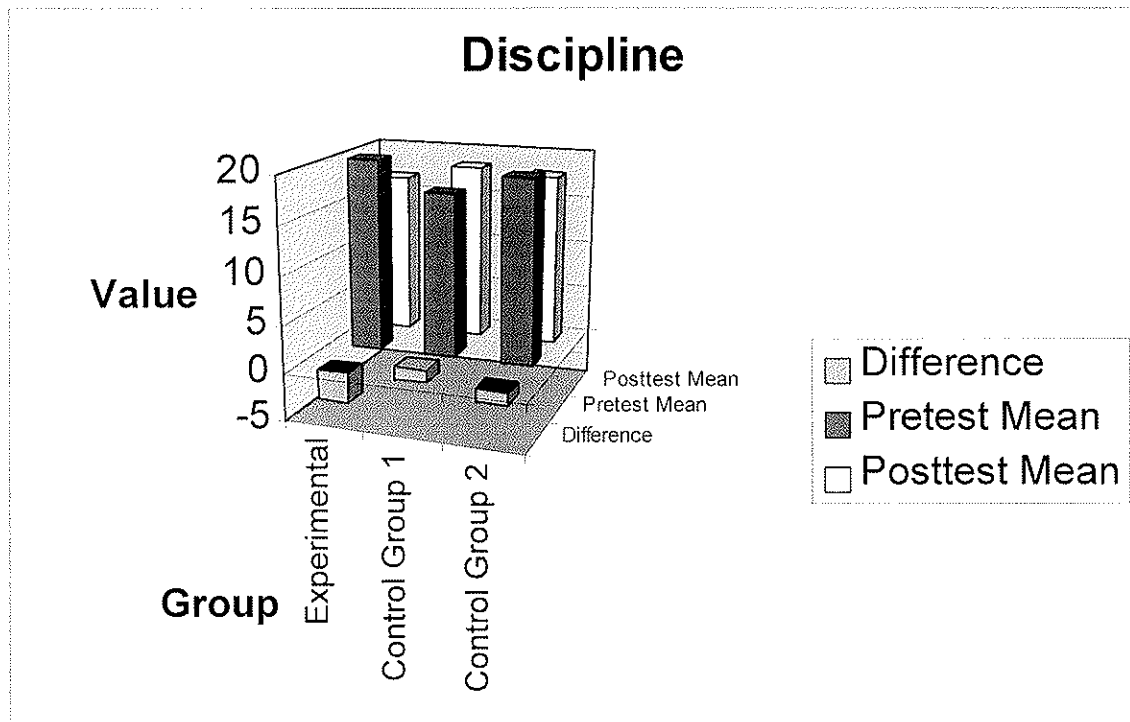
Engagement

Group	Pretest Mean	Posttest Mean	Difference
Experimental	19.4325	19.7725	0.34
Control Group 1	20	20.68	0.68
Control Group 2	14.0917	20.9083	6.8167
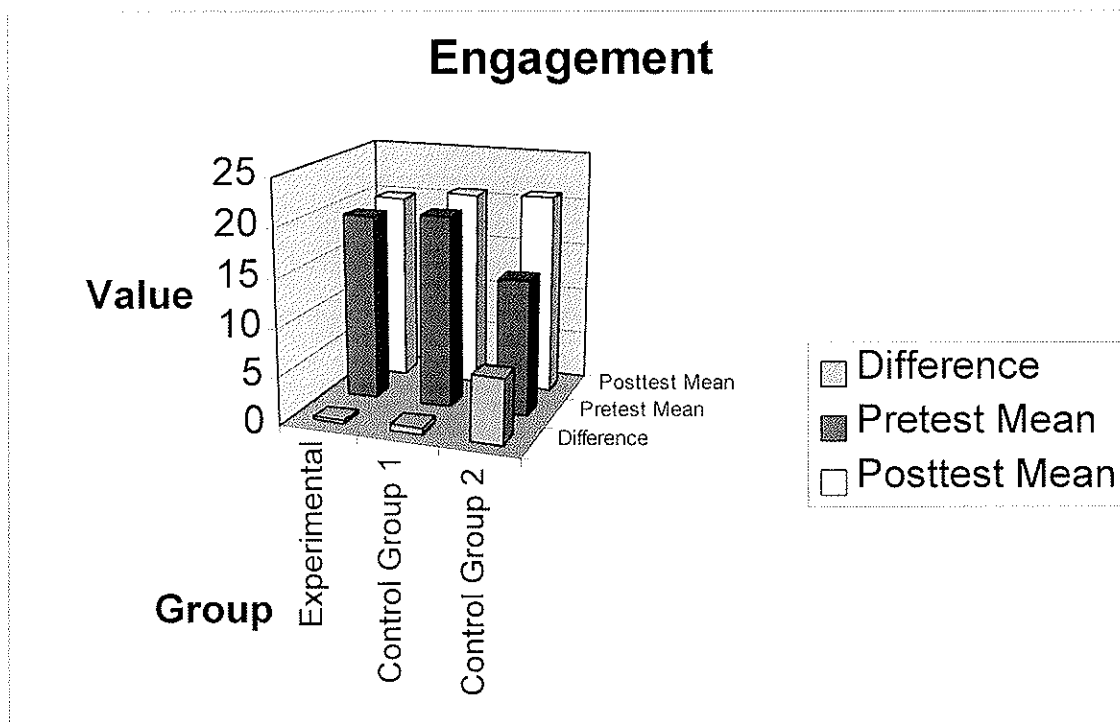
Truthseeking

Group	Pretest Mean	Posttest Mean	Difference
Experimental	18.2125	18.215	-0.0025
Control Group 1	12.8567	11.4283	-1.4283
Control Group 2	14.9983	15.7133	0.715
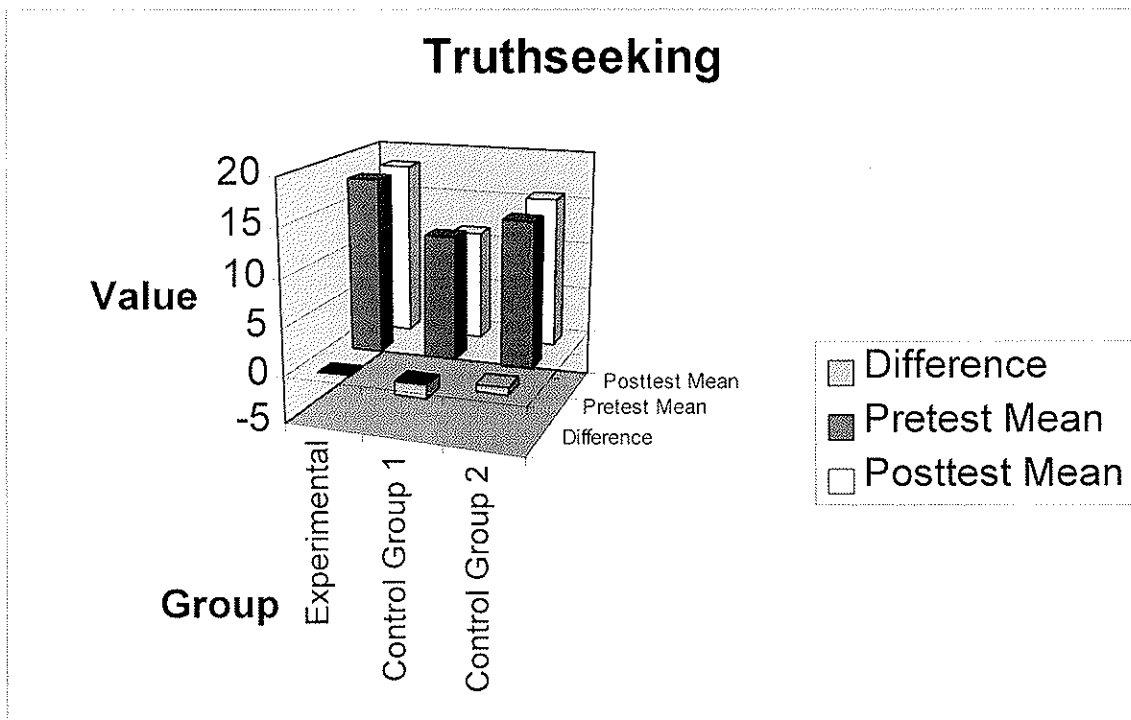
Total Score

Group	Pretest Mean	Posttest Mean	Difference
Experimental	107.7375	103.4825	-4.255
Control Group 1	101.2883	107.0183	5.73
Control Group 2	90.47	103.5667	13.0967
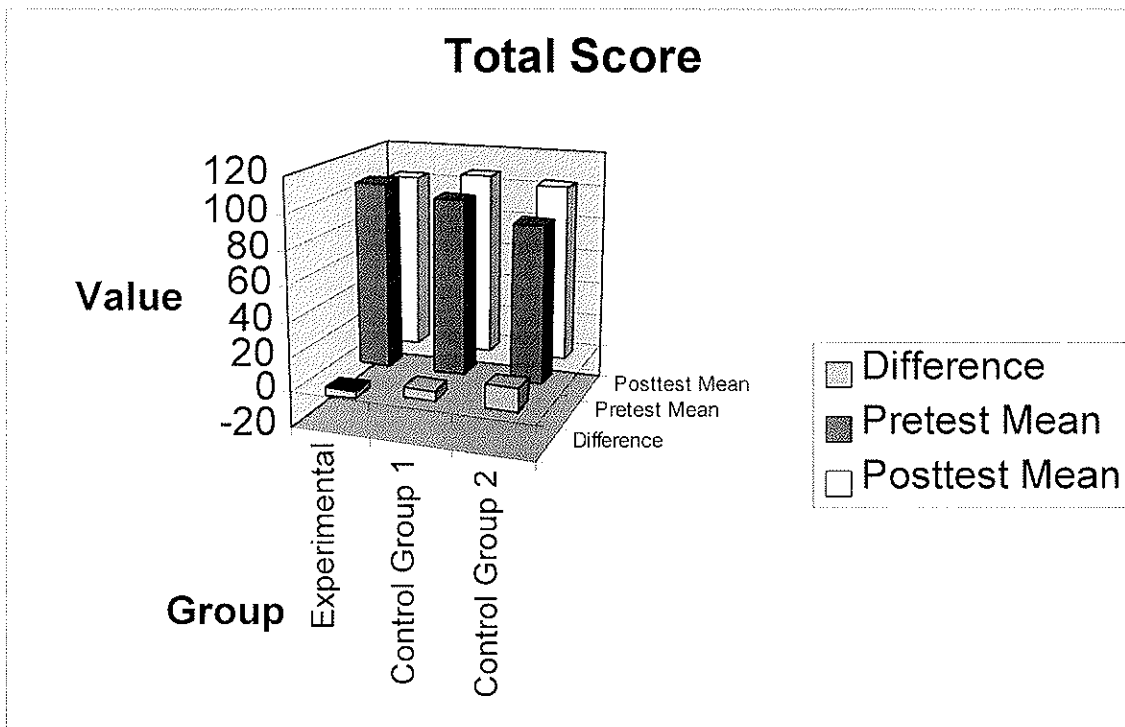
6. Analysis of Results

Mastery Orientation

The mainstream control group showed the largest improvement from the pretest to the posttest. However, the experimental group had the highest scores overall. Their scores indicate that they are just on the edge of being disposed towards this factor indicating that they enjoy challenging activities and strive to learn new things. These students are working without formal training, which presents a formidable obstacle to their ability to use complex networking systems. Microsoft offers several training courses to professionals to improve their ability to utilize Microsoft products. These students are working without this type of training, they are learning by doing. It would seem that students that were eager for a challenge would be drawn to this type of activity.

Composure

The most interesting part of this measure is the mainstream group's score. The score indicates that these students are at best ambivalent and almost negatively disposed towards this factor. A student that scores highly in this measure is confident in their problem solving abilities. It seems that the mainstream students are not particularly confident in their ability to problem solve. It would be interesting to see if this indicator is similar for a larger group of mainstream students.

Also of interest is the small increase by the experimental group. I expected that this factor would show a much greater improvement than was found. After spending a semester solving real world problems, I expected that these students would show a greater level of confidence in their problem solving abilities. However, their final score

was very close to the mainstream group's first score. This indicates that after participating in this class, the students' composure approached that of the mainstream students.

The special education control group showed both the largest improvement and the highest score which is rather interesting. I expected their score to be closer to or lower than the experimental group or at least lower than the mainstream control group.

Creativity

These results were very interesting to me. The experimental group showed a very large decrease from the pretest to the posttest. They began the course disposed towards creativity, but by the end, they were much more ambivalent. I expected them to show an increase in this measure due to the approach of the class. The students were challenged to find creative solutions to a number of hardware problems. The students also completed a number of presentations with creative methods receiving higher scores. At worst, I expected them to match the special education control group, however, this group showed a net increase of 2.5 points and once again had the highest overall score. It is interesting that the experimental group showed a higher pretest score than either of the mainstream group's scores.

Mental Discipline

Once again, these results surprised me. The experimental group showed a net decrease of over 3 points. During a visit to the classroom, I observed that there was not a great deal of focus in the classroom. Students seemed to be working in small groups on their own projects. It is possible that this approach was not focused enough for the students. Some of the tasks that the students performed were repetitious and often,

problems offered no easy solution. Perhaps some students became frustrated with this and hence became less persistent.

It is also interesting to note that none of the groups are particularly disposed towards mental discipline. It seems that these students are not organized, focused, or task-oriented. It would be very interesting to measure this factor on a larger sample to see if this trend is wide spread or isolated to these students.

Mental Engagement

The mainstream control group showed the largest increase in this factor with an almost 7 point change. These students went from being very ambivalent towards using their thinking skills to being marginally disposed to it. It would be very interesting to see if this increase was seen on a larger population and, if found, what was causing this increase.

Neither the experimental nor the special education control group showed a substantial increase though both groups did show improvement. Also of interest is that both special education groups showed a larger initial score than the mainstream students. This result would seem to go against the stereotype that special education students are not particularly engaged or motivated towards using their thinking skills.

Truthseeking

The interesting part of this factor is not the difference between the pretest and the posttest but the scores. The experimental group showed the highest scores of the three groups with a substantial difference of almost 7 points over the special education control group. Their score was almost 3 points higher than the mainstream control group. It would seem that these students are more disposed towards intellectual honesty and,

more importantly, a desire to ask challenging questions. Once again, one wonders if this kind of student is drawn out by the challenges presented by the technology classroom.

I was particularly interested in the scores of the special education control group. These students show an almost negative disposition towards truthseeking. These students do not seem to desire knowledge or show intellectual honesty.

Total Score

The most interesting part of this measure is the mainstream student group's score. While this group showed the highest increase, they also had the lowest starting score. The experimental group and the mainstream group showed almost identical final scores. I expected the mainstream group to have the highest score at both ends and hoped that the experimental group might approach the score of the mainstream group. I was pleasantly surprised to find that the special education groups showed a greater total score. Once again, it would be very interesting to test this factor on a much larger group to see if this pattern holds and if so, investigate why that might be.

7. Discussion

Conducting this study taught me a great deal. I ran into a number of problems along the way, problems that I did not anticipate. My study started with 33 participants but ended with only 16 due to a number of factors. Several students left the school district during the course of the study including three from the actually study group. The remainder of the study group did not stay in the technology class due to class conflicts. Other students either failed to complete the post test or did so in such a way that it was not scored (i.e., they filled in the bubble sheet in such a manner that it was not possible to score it).

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It seems that some students deliberately sought to undermine the test by answering all the questions the same way or scribbling on the answer sheet so that the sheet could not be scored. Some students that I observed did not take the test seriously answering in inconsistent ways. Some students openly complained about taking another test even though the CM-3 is simple and takes little more than twenty minutes to complete.

In a future study, I would incorporate some kind of self-esteem test into the study. At one point, I had intended to use a self-esteem test, but felt that too many tests would be met with resistance by the students. However, after examining these results, I feel that this would add an interesting component to the study. While I am unable to definitively prove my hypothesis, I still feel that this type of classroom can benefit students. However, these benefits may not be easy to quantify in a typical assessment tool.

The students in the study group are in the technology class only one period a day, so it is impossible to filter out any other influences on them. Perhaps the benefits of this class are not easily measured with this assessment tool or are not readily measured at all. The effects that I observed do not readily translate into a standardized test. Many of the students devote a great deal of their free time to activities of the class. I should note that there is also a computer club that has recently formed from core of the class. The students in the experimental group as well as several other special education and main stream students are members.

I think that Holzberg's article points to the true benefit that technology is having with the students in the experimental group. These students have started to serve as mentors to other students and even more powerfully to teachers. Imagine what it must be like for

these students to have teachers asking them questions. Imagine what this must do for the self-esteem of these students when an adult looks to them for answers. At one point, the principal called some of the students to his office, but not because they had misbehaved. He wanted them to use a digital camera to prepare a presentation about the school's administration. Consider what it must have been like for these students to go to the principal's office to do a task for him.

I see this as the largest benefit for these students. They are being given an opportunity to make a positive impact on their surroundings. They are being placed in control of something, and are able to help others which in turn helps themselves. It seems that many of these students can benefit from something as simple as helping a peer find something on the Internet.

IV. Future

This research should serve as a springboard to further study. I feel that it points to the need to investigate these methods further as well as explore new possibilities. Technology is continually advancing, and we must strive to find new ways to integrate new and emerging technologies into our educational systems. Maybe what is happening in this classroom is not the best, but maybe we can improve what we are doing. Through continued work with dedicated educators and forward thinking technologists, hopefully we can continue to improve the educational lives of our students.

My hope is that this research will continue at a graduate level. I would like to continue to do work in this area, to continue to explore new ways of using technology in the classroom. It would be ideal to study different technology methods in a lab school setting to try and determine what is the best use of technology. I also hope that the way

we prepare teachers changes to reflect a continuing impact of technology. Our teachers must be able to adapt, but we must also provide them with the tools and training to utilize leading edge technology.

While this study did not come to any strong conclusion, I think that it points to the need for further study. Obviously, this study was far too small in scale and we would obtain better results with a larger study. Perhaps a new assessment tool would be required as well, one that could measure more abstract factors. As I stated above, I think a self-esteem measure could show some very interesting results. Perhaps student testimonials could be taken as well though it would be difficult to administer.

V. Conclusion

While I did not definitively prove my hypothesis, I believe that this study serves as a precursor to future work in this area. Though this study yielded no statistically valid results, it did show some interesting results, results that were not entirely expected. My survey of the literature shows that there is room for more study into the impact technology has on education. It is important to remember that though this study was centered on special education students, technology has a place in all classrooms. Technology is fast becoming a part of everyday life, and we are only beginning to see the changes it will cause in how we educate our children.

Works Cited

Babbitt, Beatrice C. and Miller, Susan Peterson. "Using Hypermedia to Improve the Mathematics Problem-Solving Skills of Students with Learning Disabilities." <u>Journal of Learning Disabilities</u> Volume 29 Number 4 (July 1996): 391-401.

Coley, Richard J., Cradler, John, & Engel, Penelope K. "Computers & Classrooms – The Status of Technology in U.S. Schools." Educational Testing Service policy report. 1996.

Follansbee, Sari; Hughes, Bob; Pisha, Bart; Stahl, Skip. "Can Online Communications Improve Student Performance? Results of a Controlled Study." <u>ERS Spectrum</u> Winter 1997: 15-26.

Hauser, Jane and Mulouf, David B. "A Federal Perspective on Special Education technology." <u>Journal of Learning Disabilities</u> Volume 29 Number 5 (September 1996): 504-511.

Holzberg, Carol S. "Technology in Special Education." <u>Technology in Learning</u>. Feb. 1995 v15 n5.

Howell, Richard. "Technological Aids for Inclusive Classrooms." <u>Theory Into Practice</u> Volume 35 Number 1 (Winter 1996): 58-65.

Giancarlo, Carol Ann. Email to author. 22 July 1997.

---. Letter to author. 24 March 1998.

Pearlman, Robert. "Designing The New American Schools." <u>Communications of the ACM</u> May 1993: 46-49.

Press, Larry. "Technetronic Education: Answers on the Cultural Horizon." <u>Communications of the ACM</u> May 1993: 17-20.

United States. Department of Education. National Center For Education Statistics. <u>Digest of Education Statistics 1997</u>. December 15, 1997. http://nces.ed.gov/pubs/digest97/index.html (accessed 21 April 1998).

---.---. <u>The President's Educational Technology Initiative</u>. January 28, 1998. http://www.ed.gov/Technology/ (accessed 22 April 1998).

Works Used

"BELL Atlantic Links 677th West Virginia School to Internet." <u>CNN Custom News</u> July 21, 1997. http://www.customnews.cnn.com/cnews (accessed 6 June 1997).

"IBM to Build Online Catalog for Western Governors Univ." <u>CNN Custom News</u> July 21, 1997. http://www.customnews.cnn.com/cnews (accessed 22 July 1997).

"Technology in the Classroom – 10 tips." <u>ETSnet</u> July 25, 1997. http://www.ets.org (accessed 25 July 1997).

Becker, Henry Jay. "Teaching With and About Computers in Secondary Schools." <u>Communications of the ACM</u> May 1993: 69-73.

Blackhurst, Edward A. "Perspectives on Technology in Special Education." <u>TEACHING Exceptional Children</u> May/Jun 1997: 41-48.

Braun, Ludwig. "Help for all the Students." <u>Communications of the ACM</u> May 1993: 66-69.

Chavez, Paul. "Rural Campuses to Receive Internet Aid." <u>MSNBC</u> July 21, 1997. http://www.msnbc.com/news/86768.asp (accessed 21 July 1997).

Facione, Noreen C., Facione, Peter A., Giancarlo, Carol A. "Critical Thinking Disposition as a Measure of Competent Clinical Judgment: The Development of the California Critical Thinking Disposition Inventory." <u>Journal of Nursing Education</u> October 1994: 345-350.

Facione, Peter A. et al. "The Disposition Toward Critical Thinking." <u>JGE: Journal of General Education</u> 44.1 (1995): 1-25.

Facione, Peter A., Facione, Noreen C., Giancarlo, Carol Ann F. "The Motivation to Think in Working and Learning." Pre-publication draft. Forthcoming chapter in the <u>New Directions for Higher Education</u> series, <u>Defining Expectations for Student Learning</u>, E. Jones (Ed.), San Francisco, CA: Jossey-Bass Pub. 1997.

Hauser, Jane and Malouf, David B. "A Federal Perspective on Special Education Technology." <u>Journal of Learning Disabilities</u> September 1996: 504-511.

Hawkins, Jan et al. "Assessment and Technology." <u>Communications of the ACM</u> May 1993: 74-76.

Hawkins, Jan. "Technology and the Organization of Schooling." <u>Communications of the ACM</u> May 1993: 30-35.

Hunter, Beverly. "Internetworking: Coordinating Technology for Systemic Reform." Communications of the ACM May 1993: 42-46.

Kay, Alan C. "Computer. Networks and Education." Scientific American September 1991: 138-148.

Lauber, Gerald. "Preparing Students for a Changing Future: How one New York School District Restructured Its Educational Focus with Technology." T.H.E. Journal March 1997: 63-65.

Lewis, Rena B. et al. "Applications of Technology in Special Education: A Statewide Study." Learning Disabilities August 1994: 69-79.

Massy, William F. Address. St. John's University, keynote speaker Learnscape project. Collegeville, 8 October, 1996.

Newman, Denis. "School Networks: Delivery or Access." Communications of the ACM May 1993: 49-51.

Richman, John A. "At-Risk Students: Innovative Technologies." Media &Methods May/June 1994: 26-7.
Rubin, Andee. "Video Laboratories: Tools for Scientific Investigation." Communications of the ACM May 1993: 64-65.

Ruopp, Dick and Gal, Shahaf. "The Labnetwork." Communications of the ACM May 1993: 35-36.

Scardamalia, Marlene and Bereiter, Carl. "Technologies for Knowledge-building Discourse." Communications of the ACM May 1993: 37-41.

Schank, Roger C. "Learning Via Multimedia Computers." Communications of the ACM May 1993: 54-56.

Soloway, Elliot et al. "Reading and Writing in the 21st Century." EDUCOM Review January/February 1993: 26-29.

Sriram, Vilma. "Entering the Wired World of Education." MSNBC July 21, 1997. http://www.msnbc.com.news/51920.asp (accessed 21 July 1997).

---. "NASA Taking Internet to Classrooms." MSNBC July 21, 1997. http://www.msnbc.com/news/51922.asp (accessed 21 July 1997).