Fall 2006

Handheld Technology: Impact On Student Learning

Patricia M. Corwin
Regis University

HANDHELD TECHNOLOGY:

IMPACT ON STUDENT LEARNING

by

Patricia M. Corwin

A Research Project Presented in Partial Fulfillment
of the Requirements for the Degree
Master of Education

REGIS UNIVERSITY

August, 2006

ABSTRACT

Handheld Technology:

Impact on Student Learning

The author in this project presents research on: (a) handheld technology in the classroom, (b) challenges of handheld technology, (c) pedagogical benefits of handheld technology in the classroom, and (d) methods of technology implementation. The utilization of handheld technology in the classroom improves students' learning of concepts and skills. A major concern of the educator is that, with the use of technology, students will bypass the bridge to genuine understanding, and instead obtain a relatively effortless solution to standard problems through technology aids, while they present the appearance of mastery of a concept. However, research indicates that technology, when implemented effectively, expands student learning and alleviates teachers' concerns about whether or not the technology gives a false impression of the students having mastered material.

This information on handheld technology was dispersed to math and science educators through a Power Point presentation. The images of the Power Point presentation as well as the activities completed by the educators during the inservice are included in this project.

TABLE OF CONTENTS

Chapter 1

INTRODUCTION

Today, people live in a world that is saturated with technology, and students use many types of technology at an early age. When shopping at a local store, it is amazing to find technological toys for young children and most children enter kindergarten with some computer or handheld technology experience. Technological advances have occurred for years, but not at the current rapid rate. Despite the popularity of technology with children, some educators have had reservations about its use of technology in the classroom because of their fear that students' use of technological aids in educational settings will result in a corresponding loss of essential skills (McCluskey; 1994). The major concern of the educator is that, with the use of technology, a student will bypass the bridge to genuine understanding, and instead obtain a relatively effortless solution to standard problems through technology aids, while they present the appearance of mastery of a concept. A dominant concern, then, becomes whether a student's use of technology slows the process of understanding concepts or does it aid the student's understanding of concepts? It is the belief of this author that, even though the use of technology in the classroom has its challenges, students' use of technology can enhance and improve learning.

According to the members of the National Research Council (NRC; 1995), for the National Science Standards (NSS) and the members of the International Society for Technology in Education (ISTE; 2000), students are required to have the basic knowledge of concepts as well as the ability to apply those concepts to real world situations. Students must be creative and apply concepts in technological design and science inquiry. In order for these goals to be met, educators need to consider the use of nontraditional and innovative methods of instruction. Many researchers, including Lentz and Boe (2004), Popejoy (2003), Siskind (1995), VanDyke (1996), and Wetzel (2001), have demonstrated that the use of technology, especially handheld technology, improves students' abilities in the areas of mathematics and science. If implemented appropriately, the use of handheld technology in the classroom can enhance learning and enhance, not impede, the process of higher level thinking skills. Some educators are reluctant to use handheld technology in the classroom for many reasons, such as the difficulty in funding for technology and the reluctance of school district administrators to provide release time for teacher training in how to use technology to suit the students' needs as well as to assure the mastery of basic concepts.

Statement of the Problem

Today, society is very *High Tech*. At some colleges, students are required to have their own computer, often laptops, in order to download lessons, quizzes, projects, and grades. Also, veteran teachers, like this author, notice that students must be competent in the use of a calculator and other handheld technology. Currently, from colleges to elementary schools, educators today are required to instruct students in the use of technology as well as the basics. In order to stay current with the technological advancements, today, more than ever before, educators must include technology education in their educational curriculum. However, this author wonders whether the use of technology in the classroom impedes the process of students' learning of higher level thinking skills. Will the ease with which a student can arrive at an answer to a classroom problem with the use of technology make him or her more likely to bypass the path to actual acquisition of the concept itself and, thus, defeat the objective of the lesson? Furthermore, will the abundant pedagogical benefits of technology usage in the classroom outweigh the challenges that exist? Educators must find effective methods to instruct their students in ways that implement classroom technology and, thus, enable them to make the connection between technology, higher level thinking skills, and real life situations.

Purpose of Project

For this project, this author will develop an inservice presentation for educators, based upon the review of literature in regard to the use of handheld technology. This project will be limited to an exploration of handheld technology only within the disciplines of science and mathematics in order to limit the focus of this project. Previously, students in the mathematics classroom used pencil and paper computations; now, students use calculators. By conventional methods, in the science classroom, teachers have students use thermometers, triple beam balances, spring balances, and pH paper to gather data when they do experiments. Today, handheld technology is widely available, which allows students to read data digitally on graphing calculators when connected to a Computer Based Laboratory (CBL) and its many probes. Although many educators are hesitant to introduce handheld technology in their classrooms, in order to meet the requirements of national and state goals, students must have this knowledge. To help educators prepare students to meet these requirements, this author will prepare an inservice presentation to educators on handheld technology with emphasis on implementation and utilization in mathematics and science classrooms in ways that will not impede the students' critical thinking process. As a result of the inservice, it is the hope of this instructor that the educators will truly understand that, with the use of handheld technology in their classrooms, students will be able to grasp the principles behind the concept and, as a result, enhance and excite student learning.

Chapter Summary

Daily, educators must meet the demands of increased educational standards for students. The standards for technology education adds to that burden. Educators must help students to understand that technology is simply a tool with which they learn. Both teachers and students must work together in order to increase students' higher level thought processes. In Chapter 2, Review of Literature, this author will present information in regard to handheld technology, as well as the pedagogical benefits, challenges, and implementation methods so that educators can utilize this technology in the classroom with confidence and so that students' learning is not impaired. In Chapter 3, Method, this author will describe the goals for the inservice, target audience for the presentation, and the procedures that will be utilized.

Chapter 2

REVIEW OF LITERATURE

At a young age, children are seen in conversation on cellular telephones, and they play computer games with their X-box, or listen to their iPOD. Technology usage by students, even at a young age, is apparent in almost every classroom in the United States. Yet, the members of the U.S. Department of Education (1995) have established laws like NCLB (2001) because it is difficult for many students to learn information within a classroom setting and apply their skills to real world situations. It is this author’s goal to develop an inservice for educators to show how the use of handheld technology integration and implementation can help students to understand certain skills and concepts in order to relate their learning to real world situations.

Within this review of literature, this author will examine the challenges, the pedagogical benefits, and the methods of implementation for handheld technology in the classroom. The author will focus on handheld technology and then inform the educators about how it can be utilized in the classroom. Next, this author will examine the challenges that technology education brings directly and indirectly to a school district. Finally, the author will explore: (a) the benefits of handheld technology in the classroom, and (b) present implementation methods. The use of successful technology implementation methods is essential so that educators and students feel comfortable and confident in their utilization of the handheld technology.

Handheld Technology in the Classroom

Handheld technology refers to those instruments that students can easily hold in their hands while they are engaged in classroom activities. This project is limited to handheld technology like: (a) calculators, (b) graphing calculators, (c) Computer Based Laboratories and (d) to a lesser degree computer usage. Students in mathematics and science classes utilize these types of technology in their classroom activities. In this review of literature, the author will trace the development of technology and the requirements that must be implemented in schools.

VanDyke (1996) cited the members of the National Council of Teachers of Mathematics (NCTM; 1987, 1989) who reported that appropriate technology should be available to the students at all times. The members of the NCTM recommended that computers and calculators be used in all classrooms at all grade levels. However, VanDyke reported the schools in his study did not follow the NCTM guidelines. In fact, computers were not utilized, and calculators were not available to every student. Teachers did not instruct the students on how and when to use computers and calculators, even though the teachers used the computer on a daily basis. All of the teachers used Easy Pro, an electronic grade book program, and some of the teachers required the students to type their papers on a word processor. In comparison to other school districts, the students' use of technology was limited, and the students did not meet the NCTM standards. Computers, and especially calculators, were not used; in fact, only one of the five mathematics classrooms had a complete set of calculators. The students were required to provide their own calculators in four of the five classrooms. Of the 213 students in the sample, 126 students (60%) owned a calculator. Ironically, after a semester of observation, only 50% of those students who owned the calculator brought them to class. According to VanDyke, although many students did not feel positive about mathematics, they reported that they felt positive about school.

Vandyke (1996) cited Suydam (1982) who reported that the largest research areas in mathematics education involved calculator usage. In the 1980s, people were skeptical about the use of calculators in the classroom. Suydam reviewed 95 studies from all grades levels and subject areas of calculator usage occurred, and in 43 studies, students who used calculators scored higher than those who did not use calculators. However, in 47 studies, no differences in scores were found between the calculator group of students and the noncalculator group of students. In fact, Suydam identified 5 studies in which the noncalculator students scored higher than the calculator students.

In a later study, Hedren (1985) found that the use of calculators improved students' performance on test scores. At that time, calculators had become more accessible to students, as teachers began to see a need to advance the use of technology in the classrooms. The participants were seventh grade and high school mathematics students. Hedren found that the eight classes of the calculator students were just as competent in mental arithmetic and calculations with basic algorithms as the noncalculator students. Hedren noted that the calculator students exhibited a better understanding of word problem solving and quantitative understanding of numbers than the noncalculator students.

In addition to calculators, there has been an increased number of other handhelds in the classroom including graphing calculators and Calculator Based Laboratories (CBLs). Other forms of digital technology in use today are: (a) digital balances, (b) thermometers, and (c) pH meters. Instead of thermometers and pH meters, CBLs are used to collect data. Different types of probes, which may be attached to a CBL, record the data and the graphing calculator stores and graphs the data. The CBL and its probes can easily be taken out into the field, thus the lab experiments are not limited to the classroom.

Aleahmad and Slotta (2000) assessed the integration of handheld technology, mainly CBLs, in the classroom with the use of the Web-based Inquiry Science Environment (WISE) program. The results from the study showed that students gained a deep understanding of concepts, especially in science. The students were able to debate arguments and gain fluency with technology as well as improve their skills in literacy and argumentation.

Challenges of Technology in the Classroom

One cannot be a Polyanna about the challenges of technology. Many pioneers of technology were forthright and acknowledged the challenges that the use of technology can present to educators. For example, McCluskey (1994) compared technology usage to Gresham's Law, in that, technology usage may produce unexpected and not so pleasant consequences. Gresham, an Englishman in the 16th C, stated that "Bad money drives out good" (p. 1). This idea is related to the economics sector of government. For example, in 1964, the U.S. Treasury made coins that were no longer pure silver, and they were layered with cheaper metals in the middle. Over time, many people kept the pure silver *good coins* and kept them from circulation. Today, the layered coins remain while the pure silver ones are a rarity.

McCluskey (1994) reported that Gresham's Law compares to critical thought processes. A hierarchy of order from low to high thought processes exist. More insightful thought is needed to complete some questions than to complete others. For instance, the question of asking how many bones are in the human body takes less thought process than a question that asks a student to recall the bones of the human body. The latter question takes more complex thought processes in which more management of knowledge is required. What may happen, as Gresham's Law suggests, is that lower order thought processes drive out higher order thought processes. McCluskey coined this idea as McCluskey's Corollary.

McCluskey maintained that the acquisition of simply lower order thought processes, which are easier to acquire, are made easier by technological advances. This corollary in part accounts for teachers' reluctance to utilize technology in the classroom. For instance, students who can simply punch 7 x 12 in a calculator, soon realize that the use of a calculator to solve a problem is much easier than solving the problem on their own. The students can find that the answer is 84, but they have no internal knowledge of the process of multiplication. In the real world, because most cash registers operate on a bar code pricing system, one might argue that learning the more complex thought process is not necessary to function as a cashier. The question becomes, then, one of functionality.

According to McCluskey (1994), the digital wristwatch is another technological instrument that prevents students from the ability to read an analog clock correctly. McCluskey reported that students struggle with the phrase, “half past eleven,” instead of 11:30. McCluskey wondered if students would ever be able to understand the concept that 12:00 is north and 3:00 is east. Finally, McCluskey reported that the art of film making has impeded students’ reading and writing skills. Many students are quoted as saying, “I did not read the book, but I have seen the movie” (p. 3). McCluskey’s Corollary takes effect when it takes less effort and less processing skills to watch a movie than to read a book because more effort is required to process the written word. McCluskey believes that, if students do not read, they will never “read a sentence that sings or a phrase that stuns” (p. 3). He feels that if students cannot do that then the students will not be able to write sentences that sing or phrases that stun.

McCluskey (1994) reported that the U.S. educational system is one in distress. He feels that many educators mistakenly believe that technology itself can solve all the educational problems of declining test scores, dropout rates, and literate high school graduates. However, McCluskey stated that it is only “when the connection between the process (technology) and the knowledge (organized information) is made that thought (learning) can occur” (p. 3). According to McCluskey, technology has a place in education and it plays an important role. Nevertheless, educators must understand that the use of technology might have results that are unexpected and unpredictable. However, educators must not allow technology to be used as a substitute for real learning. If educators rely on technology to fix the educational woes, the societal gap between those, who possess knowledge and those who do not, will widen increasingly. The group with knowledge and processing skills will have fewer people in its realm.

Also, in response to criticism to technology usage in the classroom, Lentz and Boe (2004) reported that, when technology is used in the classroom, teachers feel that they are no longer an educator but just a facilitator. Also, educators find that there is limited space for technology implementation. Sometimes finding room to store the equipment is a challenge and the fact that, often, educators are limited by budget constraints to purchase technology materials make it difficult for school districts to adequately accommodate a new technological program. Finally, Lentz and Boe observed that it may be difficult to implement technology into the classroom because of limited human resources. It can be a challenge to find qualified individuals who have technological knowledge and training.

In addition to the challenges of technology that Lentz and Boe (2004) reported, Purcell (2005) reported that teachers are reluctant to teach with technology for several reasons. First, many teachers lack the space to put the technology. Teachers do not have room for computers nor so do they have a secure place to put handhelds since they can be stolen easily. Another reason for the reluctance to teach with technology is the lack of time. Many teachers have inadequate time to spend on training and workshops to learn the proper way to utilize the technology. Finally, teachers find that they lack sufficient equipment for the entire class. Too often, the technology is too expensive to purchase enough handhelds for an entire class. For instance, a graphing calculator costs over $100.00. A classroom set would be very expensive.

Another challenge of technology was identified in the Starr (1989) study. Starr found that the use of calculators is not helpful in problem solving. Starr conducted a study with 35 low income sixth grade students. The class was divided into two groups. Students in the treatment group used calculators, when they were taught problem solving skills, while students in the control group used pencil and paper. The study lasted for 8 weeks. Starr found that there were differences between the two groups. The test scores indicated that there was no significant difference in students' ability to problem solve. The students in the calculator group did not score any higher that those in the non-calculator group.

Starr (1989) was not alone in his conclusions. VanDyke (1996) observed technology usage at a junior high school. VanDyke focused on two seventh grade mathematics classrooms. The purpose of the survey was to answer three questions: "1) How is technology used in the mathematics classroom? 2) What are planned and unplanned effects of technology in the classroom? 3) What types of affective responses do students have regarding mathematics and technology used in mathematics?" (p. 54).

The data for the VanDyke (1996) consisted mostly of recorded observations of the students in the two seventh grade mathematics classrooms during one semester. Also, data were collected from interviews with teachers, students, and administrators. VanDyke (1996) found that, even though the junior high school was on the upper end of the spectrum with technology usage, students in the educational programs did not seem to show improvement. The possible reasons for the lack of improvement could be that traditional instruction was in place at the junior high school and this study was completed early in the implementation process. VanDyke believed that the junior high school was 2-3 years away from any noticeable signs of academic improvement due to technology implementation. VanDyke cited Campoy (1992) who reported that the success of an implementation process is not noticed until 5-6 years after implementation. Also, VanDyke found that only 6% of the students used a calculator and 4.4% of the students used a microprocessor while at school. Even though all students were able to use calculators on the tests, they did not possess estimation skills and could not compute mentally.

In addition, VanDyke (1996) reported that the junior high school lacked a viable implementation plan. There were no goals or guidelines established. The teachers had varying philosophies on technology usage in the classroom. In the technology plan, there should be specific goals and guidelines in regard to technology as well as written specific benefits that students will receive by their use of technology in the classroom. Technology should be integrated so that it increases student learning

Pedagogical Benefits of Technology

Despite the challenges of technology, the pedagogical benefits are numerous. The purpose of Siskind's study (1995) was to determine how calculator usage affected the rural high school student. The 48 participants, from South Carolina, were enrolled in two Algebra II classes, and these classes were divided into two groups of 22 students each. Four students did not complete the study due to illness. The two Algebra II classes, termed the control group and the treatment group, participated in the study for 5 days.

The students in the two Algebra II classes completed the same activities; the only difference between the two groups was that the control groups used pencil and paper to complete problems, while the treatment group used scientific calculators to work the mathematics problems (Siskind, 1995). Then the students solved four different types of percent problems. A comparison of the scores of the students in the control group and the treatment group indicated that the treatment group, the students who used calculators, scored higher that the control students. Factored into the study were the students' prior achievement levels based on three standardized tests. Based on the results from the analysis of covariance (ANCOVA), the two groups varied considerably. Thus, the findings showed that students who used calculators exhibited higher achievement and had a more positive outlook toward mathematics. This study lasted only 5 days, and Siskind (1995) reported that a longer term of study would be beneficial to teachers who design curricular and instructional strategies for their classroom.

In a similar study, Wetzel (2001) reported that students benefit from the use of handheld technology. Each school district in Virginia was provided with funding in order to implement handheld technology into the classroom. The educators, middle school science teachers who were unfamiliar with the technology, chose to implement the Texas Instrument CBL and its probeware. Their teaching experience ranged from 11-33 years, and all had at least 6 hours of college credit in technology. The purpose of the CBL is to provide digital data during laboratory experiments conducted primarily in science classes. However, the CBL is used in mathematics classes. Different types of probes can be attached to the CBL which can measure many different types of data. For instance, there are probes for: (a) temperature, (b) pH, (c) light intensity, and (d) motion. The CBL is attached to a graphing calculator, and the calculator records the readings and assigns numeric values to the data. The CBL is controlled by the programs on the graphing calculator, and the probes measure the data. With the use of the CBL, the experiment time is cut in half in comparison to the use of traditional data collection instruments. Students read the digital displays and record the data on their data sheet or save it on the calculator.

From August to December of 1999, the educators in the Wetzel study used the CBL and its probeware in various experiments in the science classroom. Based upon interviews and observations, Wetzel (2001) reported that the use of handheld technology was valuable in the classroom. The educators believed that the use of handheld technology improved the students' understanding of many science concepts. The educators felt that, with the use of real time data and manipulated variables, the students could draw better conclusions based on their data. Four of the educators who participated in the Wetzel study felt strongly that the students' test scores in the future would improve due to the use of the CBL and its probeware.

Popejoy (2003) reported that the use of instructional technology enhanced students' interest in astronomy. The focus of the study was mainly on computers, but Popejoy included any type of instructional technology. Popejoy reported that students accessed current information through the use of the Internet which enhanced their research and presentation skills. The instructional technology was an enhancement to the inquiry based curriculum. The 4 month long Popejoy (2005) study with fourth and fifth grade students at Bayside Elementary School in a Pacific Northwest state, asked students to complete a research project on an astronomy topic. Using only eight computers in the classroom, the students worked in groups of 2-3 to complete their tasks. The students developed travel brochures and power point presentations. Even though this study did not involve handhelds, the educator implemented a different form of technology into the classroom which proved to be enrichment to the science curriculum and allowed the students an opportunity to research real time data and real phenomena.

Perhaps one of the strongest indicators for the use of technology in the classroom is the motivation it provides. Educators Lentz and Boe (2004) reported that, when students walk into a classroom filled with technology, the technology will sell itself. The assessment of projects that utilize technology has led to a more complete evaluation of student work. With the creation of scoring rubrics, peer grading, portfolios, and presentations, students evaluate each other's work based upon mutually agreed upon criteria. Students provide feedback for each of the components in the project that are present in the rubric. The use of peer review can provide very positive results especially in engagement. The students discuss the strengths of their project and the areas that need improvement. The use of instructional technology encourages community involvement. Often, parents and foundations are eager to donate materials to technological design projects, and administrators enjoy observing the students when they are actively engaged in the activities in the classroom.

Also, Kwon (2002) reported that a hands-on learning style motivates students to learn. Kwon study used handheld technology that included the Calculator Based Ranger (CBR), and the graphing calculator, a motion detector and data collector. Kwon conducted a study to evaluate the effectiveness of students' graphing skills with the use of the CBR. None of the students had used the CBR or graphing calculators prior to this study. The seventh and eighth grade students participated in activities with the use of the CBR and graphing calculators during the study, while the eleventh grade students were in the test only group (TOG). The TOG was strictly a lecture/based group that did not use the CBR or graphing calculator.

All of the students took the pretest and participated in skill enhancing activities that connected the graphing to real life (Kwon 2002). For instance, the students participated in a walk like a graph activity. In this graph activity, the students looked at a graph on the graphing calculator screen and tried to predict the best way to walk to create that graph. Then, another student pressed a button on the calculator, and the CBR activated. The first student attempted to walk in a manner that would create a graph like the original sample.

Kwon (2002) reported that the seventh and eighth grade students' mean scores increased from 28.83 to 42.82 from pretest to posttest. The higher scores were evident in the areas of interpreting, modeling, and transforming. Prior knowledge of graphing skills did not affect the students' graphing abilities. The seventh grade students, who had no prior knowledge on the Cartesian Plane, did equally as well as those students with prior knowledge of the Cartesian Plane. Also, the results indicated that the eleventh grade students scored a mean posttest score of 15.83 which was lower in all the components of the study when compared to the mean posttest scores of the CBR group. Kwon's finding seemed to indicate that the use of CBR activities were an effective method to improve students' graphing abilities. Kwon believed that the CBR success was mainly the result of the nature of the CBR activities which provided a physical experience for the students, and real time graphing so there was immediate graphical feedback to connect real life experience to graphs. Therefore, students had frequent repetition and many opportunities to experience graphing in the real world. Even though there were limitations to Kwon's study, use of hands-on style of learning enhance a students' ability to understand concepts.

Methods of Technology Implementation

The benefits of technology are many and varied but student learning cannot occur without an effective implementation plan. According to Duffy (1980), Columbus Public School teachers and administrators decided that change was needed in their mathematics curriculum in order to improve students' mathematical skills. The study consisted of 90 participants who were divided into three groups. One group used calculators with a student instructional package and had a trained supervisor, another group used just the calculators with no instructional package or supervisor, and a third group received the regular mathematics instruction without calculators.

Duffy's (1980) results indicated that, after 2 years of the study, two of the nine objectives were met. The two objectives were related to teacher training and understanding of the use of the handheld calculators. Teacher instructional materials were developed and incorporated in the classroom. Even though the study lasted only 2 years, the three month gain in students' grade equivalent scores indicated that students' performances improved. Parents indicated that the use of the calculators in the classroom was a positive approach to teaching mathematics, and their opinions on the use of calculators helped to build the bridge between the home and school.

Another implementation plan consisted of three phases or waves in the VanDyke (1996) study. VanDyke (1996) reported that, in the first wave in the technology plan, the administrators of the school district conducted an inservice for the educators in order to acquaint them with computers and handheld technology. The leaders of the inservice instructed teachers on how save and retrieve documents from a server. The second wave involved methods of instruction that enabled students to learn the technology. In the third wave, teachers incorporated technology into their lessons requiring students to use computers to complete their lessons.

Similar to VanDyke's third wave, Pennington (1998) reported that proper instruction on new technology is crucial to students' success. The Pennington study included three groups of 98 seventh and eighth grader students. The control group did not use calculators, the second group used calculators without instruction, and the third group used calculators and received instruction in use of the calculator. All three of the groups took a pretest and a posttest. Pennington reported that the group with the highest test scores was the group that received instruction on how to use the calculator. Also, the results indicated that the students, who did not receive instruction on the calculator, did not improve their performance on the test, and their scores were similar to those of the noncalculator group. Pennington concluded that students must be trained on how to use the technology before they can utilize it to its full potential.

Thus, Pennington's (1998) concerns raise the question of implementing technology into the classroom. Pownell and Bailey's (2001) plan of implementing technology included: (a) a competent leader who understands the importance of technology in the school and who will oversee all of the components of the implementation, (b) staff development, (c) technology support, (d) proper planning, (e) health and safety of the student, (f) ethics, (g) evaluation of the curriculum yearly, (h) security, (i) update equipment, and (k) keep the technology affordable.

A similar implementation plan by Wetzel (1999) proved to be successful in schools. Wetzel wanted the implementation process for the new technology to be effective and long lasting. The CBL and its probeware was the new technology introduced in this study, Wetzel evaluated the implementation process. Wetzel's method of implementation, the ST^3AIRS Model, is a step by step process that provides teachers with support and guidance during and after implementation of technology. The multistep process consists of an eight step sequence that begins with Staff Development. For Staff Development, teachers attended an inservice about how to implement the technology. The three t's in ST^3 represent time, trainers, and transition. The teachers were given time to learn the technology from trainers who were experts. The transition was time allowed for the gradual implementation of technology in order to meet the comfort zones of both the teacher and student. The teachers then needed access to the equipment and then the next step was involvement. Teachers needed to be actively involved in the process.

The last two steps of the model are recognition and support. By the receipt of recognition and support, the teachers felt positive about their efforts.

Wetzel (2001) reported that, according to the teachers, there were some strengths to the ST^3AIRS Model. The teachers felt that staff support, time, lack of pressure, collaboration, and exploration were instrumental to the success of the technology implementation. Also, they demonstrated their interest in the implementation process when they applied for grants to purchase additional CBL's and its probeware. Since the teachers had only one set of probeware during the study, they adjusted their science department budget to acquire additional probeware. According to Wetzel, the ST^3AIRS Model proved to be successful at least on a short term level. The teachers exhibited pedagogical and curricular transformation. Based on the positive attitude and motivation of the teachers, the model may provide a long term foundation for technology integration.

Chapter Summary

Presented in this chapter was an overall view of handheld technology used in schools today. Primary handheld technology in mathematics classes are calculators and graphing calculators. In science classes calculators, graphing calculators, CBL's, CBR's, and digital instruments like thermometers, balances and pH meters are currently used by students doing a variety of experiments. While not all studies show positive results, those of Suydam (1982), Hedren (1985), and Aleahmad, Slotta (2000) reported that the use of handhelds motivated students and increased positive attitudes for student learning.

But the use of technology in the classroom is not without challenges, McCluskey (1994) reported that while technology does not solve all the problems in classrooms today, it has a place in education. Lentz and Boe (2004) and VanDyke (1996) reported challenges in technology use. Most researchers agree that both teachers and then students must be comfortable and confident using the equipment before the technology implementation can be successful in any school. Overcoming the difficulties, however, can produce considerable rewards. Benefits exist when handheld technology is used by students in the school setting. Siskind (1995), Wetzel (2001), Popejoy (2003), Lentz and Boe (2004), reported improvements in the work of students using handheld technology. Wetzel (2001), Kwon (2002) also reported the understanding of science concepts enhanced students' learning. Finally, Duffy (1980), Pennington (1998), Pownell and Bailey (2001), VanDyke (1996) and Wetzel (2001) reported that a feasible technology implementation plan by school districts must exist if school districts want technology education to be long lasting and pedagogical.

In Chapter 3, this author will provide information that is pertinent to the teacher inservice presentation in reference to the use and implementation of handheld technology in the classroom. The target population, procedures, goals, and assessment will follow in detail.

Chapter 3

METHOD

According to Fryer (2005), a member of the Technology Integration Academy, by the time the current fifth grade students graduate from high school, 85% of their jobs will not yet have been created. Educators, who continually seek ways to motivate students and enhance learning, must recognize the importance of instruction to current students to use technology that supports the traditional instruction. The integration of technology with traditional curriculum was the focus of the inservice training session during which educators were given tools that they could use in the classroom to enhance curriculum and introduce many forms of handheld technology. Within the inservice, it was hoped that the teachers will gain long lasting and successful results that will be of great benefit to their students' future.

Target Population

The target population for this inservice was educators who provide instruction to students in the fields of mathematics and science. The handheld technology can be integrated easily with the science and mathematics curriculum. Also, the target population included administrators and curriculum specialists because they help design curricula and approve the funding for the implementation of the technology in the classroom. The inservice provided information for educators about handheld technology and introduced lessons that teachers could use in the classroom. The lessons provided showed how easily the handheld technology could replace traditional technology. The teachers created new lessons and activities that use technology into their already existing curriculum.

Goals of the Handheld Technology Inservice

The goal of this inservice was to inform educators, administrators, and curricular specialists on the importance of handheld technology in the classroom. This inservice informed teachers about the pedagogical benefits of handheld technology in the classroom, challenges educators may encounter when implementing the technology, methods for technology implementation, and provided sources for funding for the technology. During the inservice, the participants participated in lessons that use handheld technology. The participants revamped a mathematics or science lesson of their own and created a new one with the use of handheld technology. Finally, the participants completed a formal evaluation of the inservice. It was the hope of this author that the participants would consider the use of handheld technology in the classroom and concluded that handheld technology is a powerful tool to use in order to enhance curriculum, motivation, and sparked the interest of the students in their education in order to increase knowledge and increase students' skills.

Procedure and Peer Assessment

The Handheld Technology Inservice began with a power point on an overview of handheld technology. In the power point, the author emphasized certain facets of the technology that will be of interest to the audience and, eventually, the students. The contents of the power point included examples of: (a) handheld technology, (b) pedagogical benefits of handheld technology, (c) challenges with handheld technology, and (d) implementation methods of handheld technology, and (e) examples of handheld technology use in the classroom. At the conclusion of the power point, the participants participated in activities (Appendix A) that integrate technology in the areas of mathematics and science. After their physical performance of the activities, the participants brainstormed new ways that handheld technology can fit into their own curriculum as they took a familiar lesson of their own and put the handheld technology in place of the traditional technology. Finally, the participants evaluated the inservice by completing an evaluation form. (Appendix B)

Chapter Summary

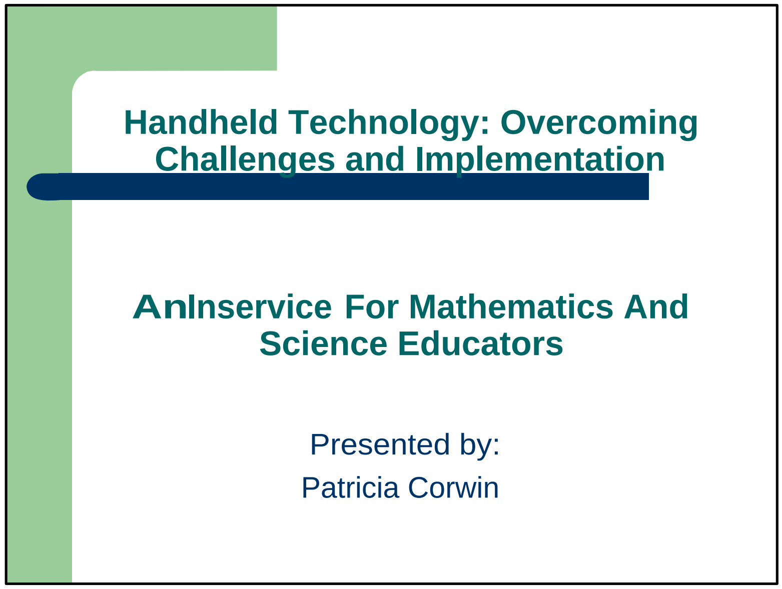
Today, more than ever, technology must be used as a tool and taught in schools since the students of the future will have access to it on a daily basis. Currently, educators have experienced the use of computers, calculators, and cell phones, and their students are growing up with these technological tools. It is vital for students to learn about the past but, also, about the future. Without teacher training about handheld technology, the participants will not expose their students to the many means of communication that can enhance students' learning and in essence raise students' achievement scores.   It is this author's hope that this inservice provided the means by which the participants learned more about handheld technology and became comfortable in their use of the technology in the classroom.

Chapter 4

RESULTS

In order for educators to meet requirements in technology at the federal, state, and local levels, school districts need a technology curriculum. Some school district administrators have purchased technology equipment for their school for the sole purpose of keeping up with appearances of neighboring school districts. Many times educators who are supposed to implement the technology lack training and feel inadequate and uncomfortable using it. However, they are aware of the need to meet the educational requirements of their students through instruction in various forms of technology and they acknowledge that technology in the classroom is beneficial to both them and their students. To overcome the challenges of establishing a strong technology curriculum, a successful implementation plan is necessary to insure that the technology is appropriate for the subject area. One classroom technology that is non-threatening to the instructor as well as beneficial to the student is handheld technology, a technology that is easily adaptable in lessons that once used more traditional methods.

The purpose of this inservice is to inform educators that handheld technology can easily be incorporated into their classroom. When teachers use the handheld technology in connection with classroom activities, it can be an effective way to stimulate higher level thinking skills and ultimately, improve test scores.

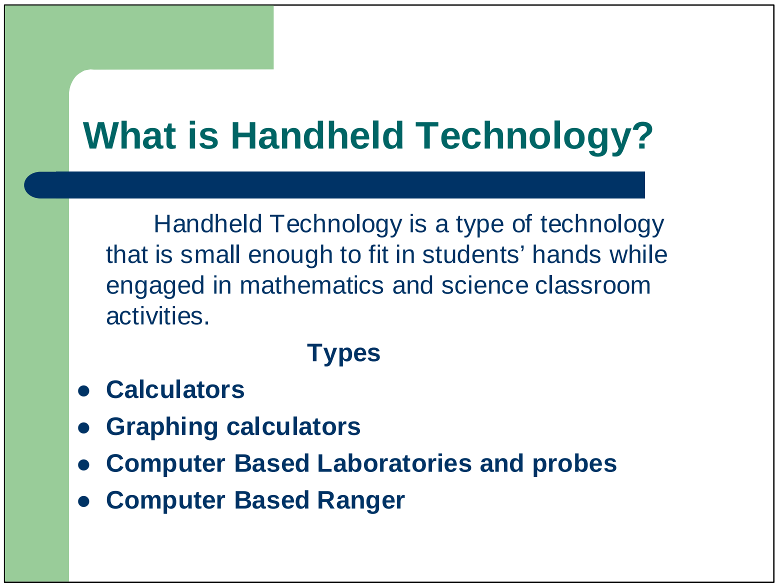


Educators of math and science curriculums, administrators, and technology coordinators, welcome to this inservice. This inservice entitled, Handheld Technology: Overcoming Challenges and Implementation will expose you to types of handheld technology for the classroom that when used with students can stimulate learning.

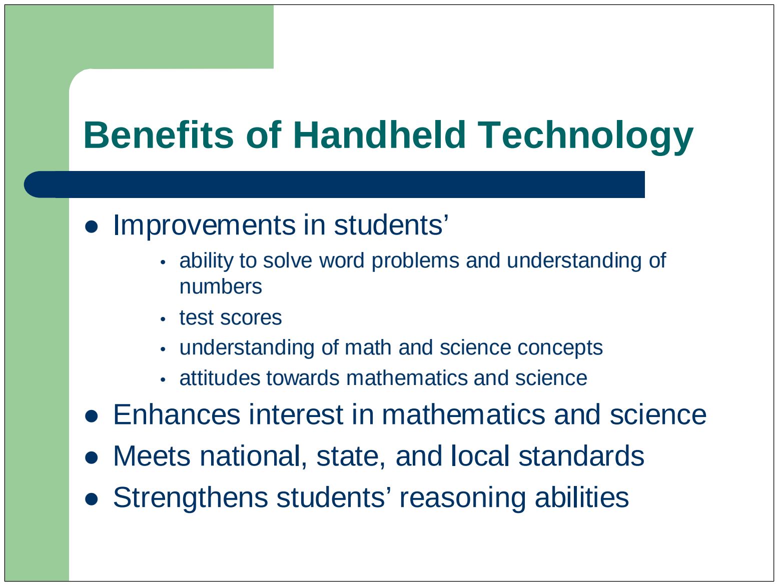
Students' negative attitudes change to positive when they are told they are going to the computer lab to work on a project or to do research. Also, it is interesting to observe students when they walk into a classroom and find materials on their desks. Most students are inquisitive and want to manipulate the materials. In fact, some students have a hard time keeping their hands off the equipment until their teacher instructs them to do so. A "hands-on" curriculum with such assured interest has the added benefit to stimulate learning and allow students to manipulate real life. A technology curriculum, which is "hands-on," can motivate students to learn concepts that may otherwise be difficult for them to master.

Handheld technology is technology that can easily be adapted into any mathematics and science curriculums. Mathematics concepts such as graphing can easily be understood using a motion sensor, CBL and graphing calculator. Science classrooms have a readily available lab that may run more efficiently when using a CBL, graphing calculator, and its probes. A temperature probe, for example, digitally records temperature and can be used in place of a thermometer to speed up an activity enabling the class to have time at the end of the period for discussion and application of higher level thinking skills. As this inservice progresses, educators will find that the use of handheld technology can be a useful tool for students in their classrooms. (The presenter will move to the next slide.)

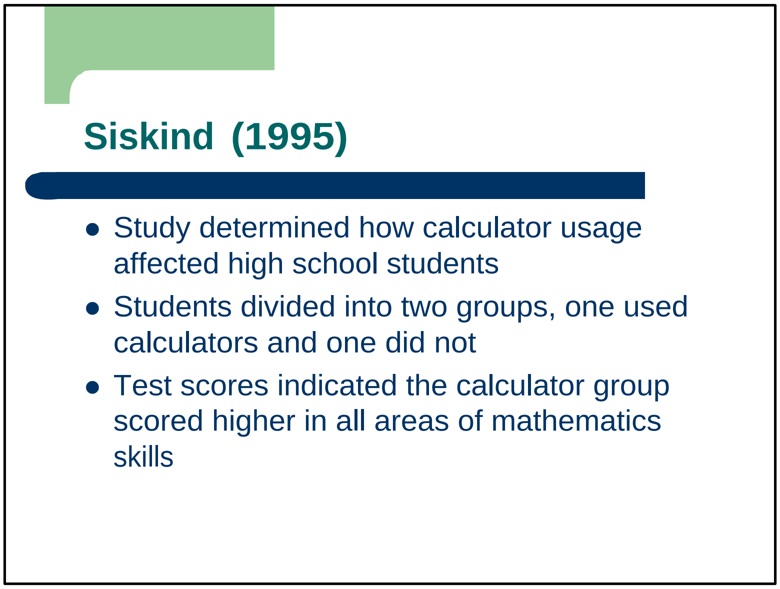
This inservice for educators will cover five main topics. (a) A quick overview of handheld technology and the equipment that it includes, (b) research supporting the benefits of handheld technology in the classroom, (c) challenges for school districts and educators, (d) a proposed plan of implementation to eliminate frustration for teachers and students, (e) a “hands-on” experience will familiarize teachers with activities using handheld technology, (f) a breakout session in which teachers will brainstorm how they might use their existing lessons to incorporate handheld technology. (Presenter will move to the next slide.)



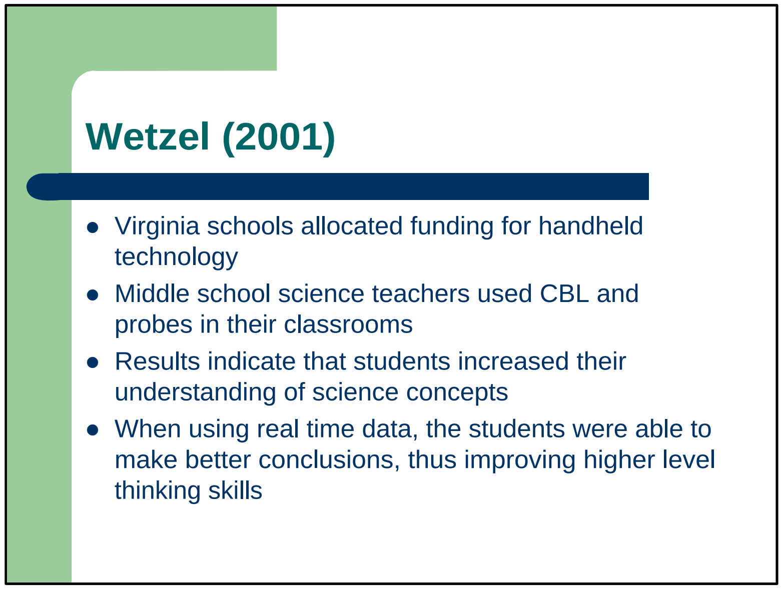
Handheld technology is technology that is easily used in any classroom because it fits into students' hands while they are engaged in mathematics and science classroom activities. In addition, handheld technology is relatively inexpensive and easily stored. Some types of handheld technology include: calculators, graphing calculators, Computer Based Laboratories (CBL), and Computer Based Ranger (CBR). The least familiar to educators are the latter two types of technology. The CBL is a device that when connected to one of its probes and a graphing calculator can gather data and record it on the graphing calculator for graphing purposes. Students can use various probes to detect data relative to motion, temperature, pH, light intensity, and voltage for a science and mathematics activity. Also, the graphing calculator has the ability to download programs from a computer in order to be used in the classroom. The CBR is similar to a CBL but only has the capability of measuring motion. A CBR is used in physical science classrooms and some mathematics classrooms. (Presenter will move to the next slide.)



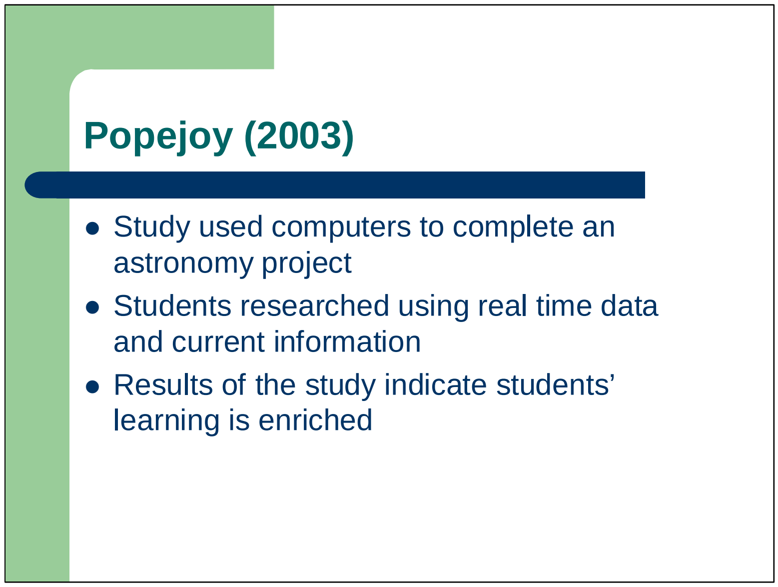
Research indicates that handheld technology can benefit educators and their students for various reasons. Researchers have found that there has been significant improvement in students' ability to solve word problems and understand numbers in mathematics classes. Test scores on the national, state, and local levels have improved. Teachers have noticed students have a more positive attitude towards mathematics and science. When students use real time data, they are able to draw better conclusions thus improving higher level thinking skills. Handheld technology enhances students' learning and motivates them to learn. (Presenter will move to the next slide.)



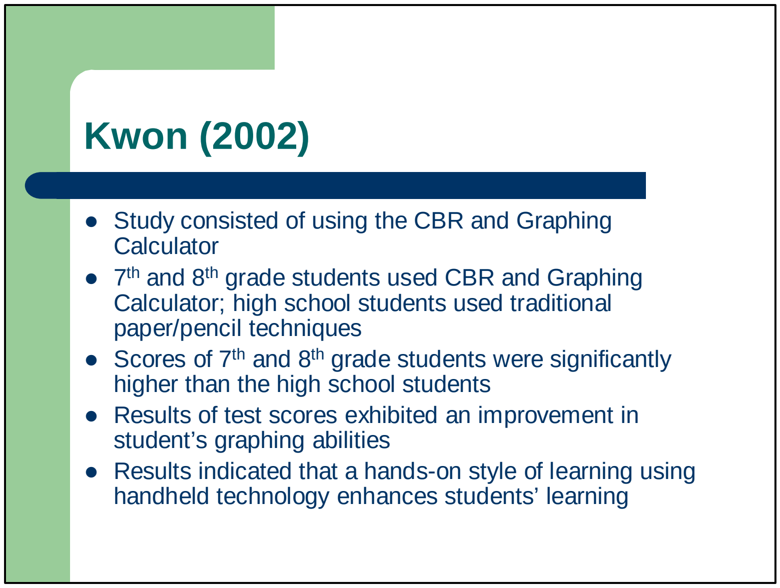
Siskind (1995) conducted a study to determine the students' improvement in test scores with the use of a calculator in high school classrooms. Her study divided the Algebra II students into two groups, students who used calculators and those that did not. The students completed the same kinds of activities for five days. The activities were percent word problems that require multi-step problem solving. The only variable in the study was the calculator. At the conclusion of the study, the students took a post test and an interest inventory. Results indicated that the group who used the calculators scored higher than those that did not use the calculators. Based on her study, the students who used calculators exhibited higher achievement and had a more positive outlook towards mathematics. (The presenter now moves to the next slide.)



Similar to Siskind's findings, Wetzel's (2001) study reinforces the theory that handheld technology benefits student learning not only in mathematics classes but also in science classes. Knowing that schools must accommodate for the growing technological world, the Virginia school district administration allocated funds for the purchase of handheld technology for students. The teachers chose to purchase Texas Instrument graphing calculators, CBL's, and probes in order for middle school students and teachers to aid in science experiments. Students used the handheld technology with their laboratory experiments for 5 months. After many interviews and observations, the teachers felt that the overall understanding of science concepts improved. Wetzel (2001) concluded that when the students use real time data, they are able to make better conclusions at the end of the laboratory experiment. (Presenter will now move to the next slide.)

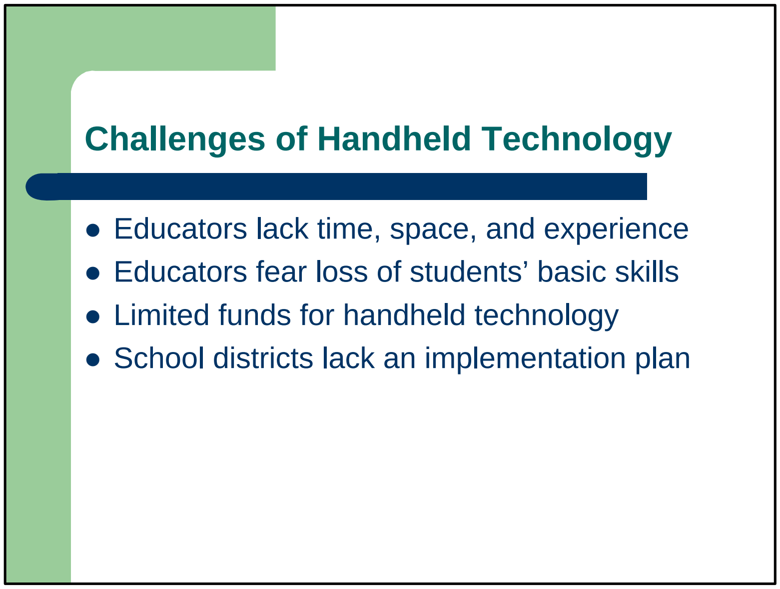


Popejoy (2003) used computers to enrich student learning. Even though this researcher did not use handheld technology, computers are a form of technology. In this study, a teacher of a split class of 4th and 5th grade students studied astronomy. The students were to do a project using the 8 computers in the classroom. Because of limited references in the school library, the students used the computers to look up current information in order to develop a travel brochures and power point presentations. Popejoy (2003) reported that the use of instructional technology enhanced students' interest in astronomy and that students' ability to access current information through the use of the Internet enhanced their research and presentation skills. Even though this study did not involve handhelds, the teacher implemented a different form of technology into the classroom which proved to be enrichment to the science curriculum, and allowed the students an opportunity to research real time data and real phenomena. (The presenter will move on to the next slide.)

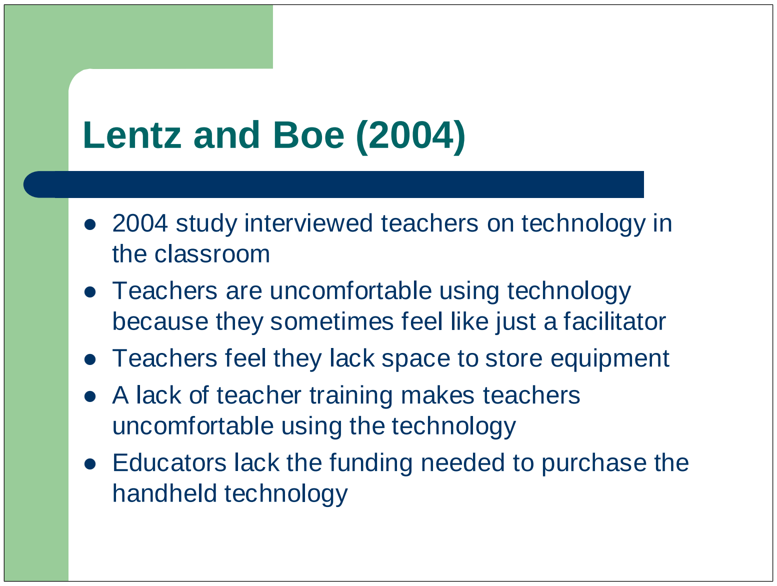


Kwon (2002) conducted a study that used the CBR and graphing calculator. Similar to the other researchers, this study reported that by using handheld technology with students enriched their curriculum. The participants in this study consisted of three group: 7^{th} grade students, 8^{th} grade students, and high school students. The 7^{th} and 8th grade students used the CBR and the graphing calculator with activities in the classroom while the high school students used the traditional paper/pencil techniques. For five days all of the students participated in activities involving distance/time graphs and velocity/time graphs.

Kwon reported scores of the posttest were higher that those of the high school students. Students' graphing abilities improved and the results indicated that a hands-on style learning enhances student learning. (The presenter will now move on to the next slide.)



Even though technology has its advantages, educators must realize that its utilization is not a cure for all educational problems. When teachers introduce technology into their curriculum, they are concerned about their lack of time that they have to learn the new technology, the lack of space to store the technology, and the lack of experience that they feel they have about teaching the technology to their students. Educators also fear that students may lose basic skills because they would become too dependent upon the usage of the technology. School districts are also concerned with limited funding to purchase the new technology; thus, educators fear that they may not be able to purchase all the necessary technological components. Finally, many school districts lack a feasible implementation plan that will fit the district's needs. (The presenter will now move to the next slide.)

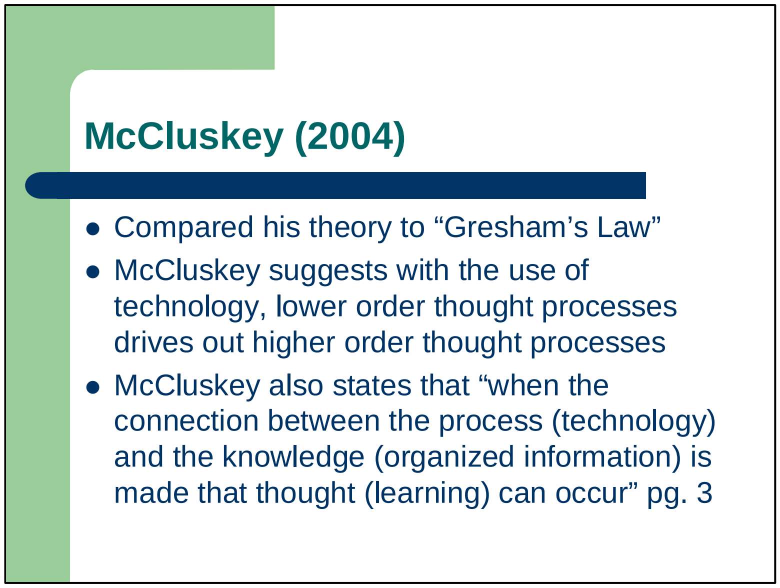


Educators Lentz and Boe (2004) expressed concerns over implementation of new technology in teachers' classrooms. Lentz and Boe felt that technology implementation into the schools was positive for students; however, some teachers had reservations about the utilization of technology in the curriculum. For instance, some teachers felt as if they were no longer teaching skills but acting as a facilitator, a change they were unable to view positively. Teachers who use technology effectively with their students are in reality more effective instructors, as they are both teachers and facilitators. In essence, teachers should facilitate student learning so that the students become independent learners and seek out information actively instead of passively.

Another concern of the educators that Lentz and Boe interviewed was that storage areas for the technology are difficult to find. The technology is very expensive and the teachers felt that it needed to be locked up daily, so finding a secure area was a concern. Technology, such as computer monitors, towers, and keyboards, do take up a lot of space, unlike handheld technology which can fit easily in small boxes. Teachers tend to hold on to a lot of materials, so it is always good to filter through materials every five years or so in order to make room for current and updated materials.

Teachers find that they have limited funds for getting the handheld technology. Handheld technology, once purchased, can last a long time however. Funding could be sought out through additional resources, like local businesses, foundations, and local parent-teacher organizations.

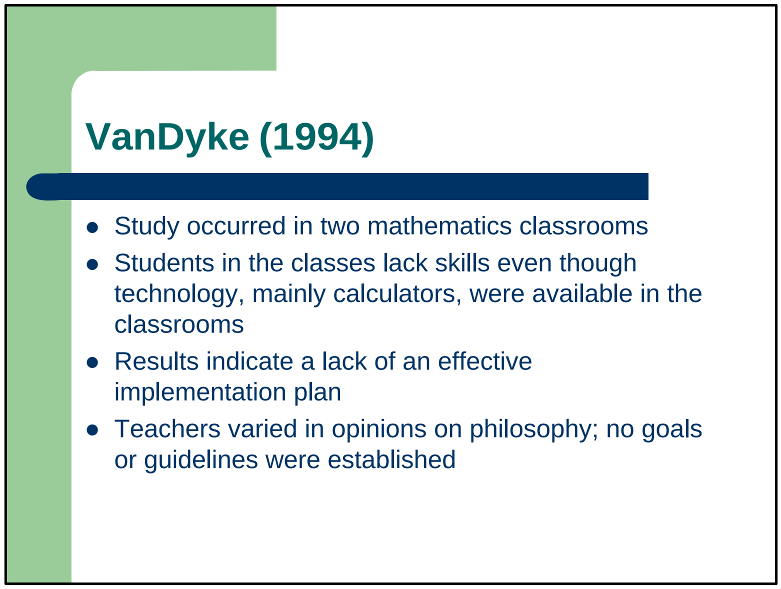
Handheld technology is new and sometimes difficult to use. Many teachers feel uncomfortable using it because if they encounter problems with the technology, they cannot tell their students how to remedy the situation. This situation is no different than the times when teachers struggle using the overhead projector, VCR, or DVD. A media specialist is often summoned to assist with the problem. Perhaps a technology coordinator can assist in trouble shooting problems when they arise. Having several training sessions for the teachers on handheld technology can alleviate teachers' reluctance to use it with their students. (The presenter will move to the next slide.)



Educators have a concern that students will relinquish basic skills if they use technology too much. McCluskey (2004) compares technology usage to Gresham's Law. Gresham was an economist that coined the phrase, "bad money drives out good" (p. 1). Years ago silver coins were replace by coins that were plated only in silver. People began saving the pure silver coins instead of spending them. After several years, the pure silver coins were no longer in circulation.

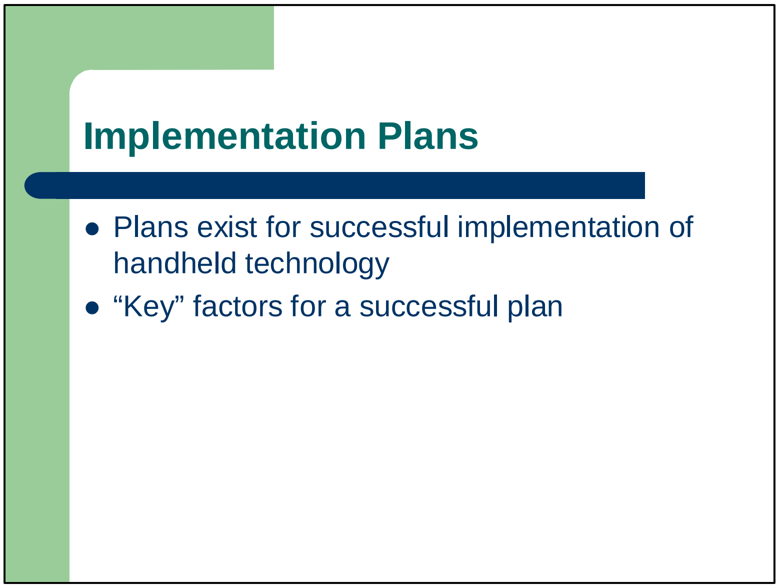
McCluskey compares Gresham's idea to technology usage and suggests that with the use of technology, lower order thought processes drive out higher order thought processes. For example, with the use of technology, store personnel no longer have to count change back to people because the cash register does the work for them. Thus, we lose that skill unless it is practiced.

People need to realize that in an advancing technological age, while it is still important to teach the basics, one needs to prioritize the learning. If the technology being used is not going to interrupt students' learning basic skills, then it is perfectly all right to use. For instance, if a science teacher wants her students to learn about color absorption and not teaching temperature then it would be advantageous to use the handheld technology with a temperature probe to speed up the experiment. Students will then have more time to synthesize and analyze the data gathered by the handheld technology, encouraging higher level thinking skills rather than suppressing them. (The presenter will now move to the next slide.)

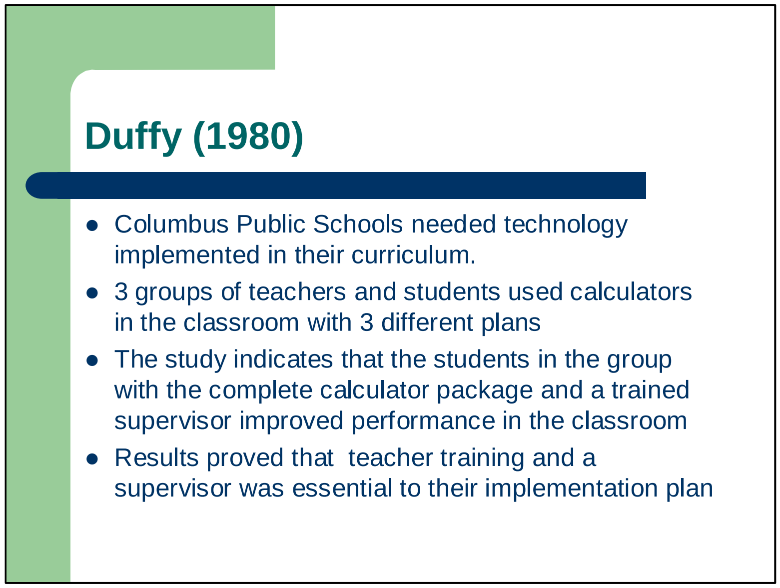


The study by VanDyke (1994) reported that lack of an effective implementation plan was to blame for the students' lack of skills in mathematics classrooms. The data for VanDyke (1996) consisted mostly of recorded observations in two 7th grade mathematics classrooms during one semester. Also included in the data were interviews with teachers, students, and administrators.

VanDyke (1994) reported that the technology implementation was not successful. Students' scores did not improve mathematical skills using technology. A possible reason for the lack of improvement in students' mathematical skills is that this study was completed early in the implementation process. VanDyke believed that the junior high school was 2-3 years away from any noticeable signs of academic improvement due to technology implementation since the implementation process is not noticed for 5-6 years after implementation. Also, VanDyke found that only 6% of the students used a calculator and 4.4% of the students used a microprocessor while at school. Even though all students were able to use calculators on the tests, students did not possess estimation skills and could not compute mentally. The math curriculum was textbook-driven so there were not many opportunities for alternative assessment. Additionally, VanDyke believed that the school district lacked a feasible implementation plan. He felt the teachers lacked goals and objectives written specifically for the technology. The integration of technology should be done so that it increases student learning. (The presenter will move on to the next slide.)

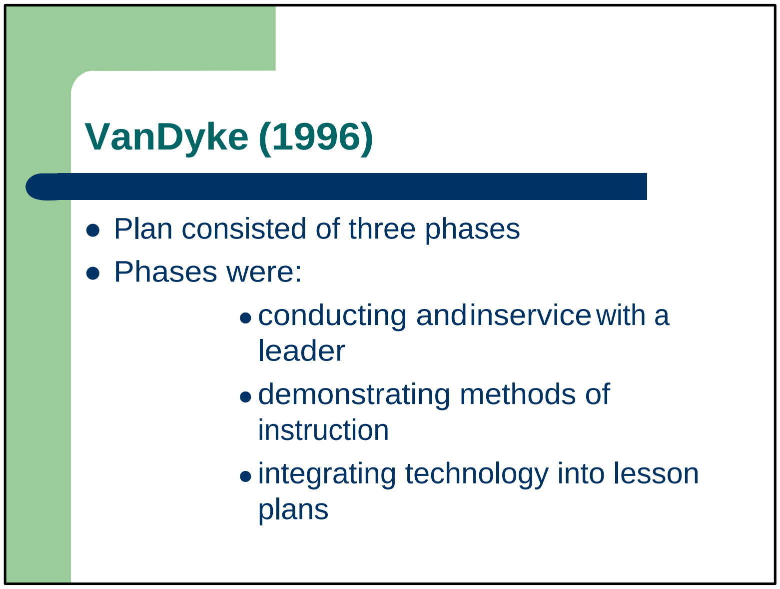


As VanDyke suggests, a successful implementation plan for handheld technology gives direction and focus. Researchers like Bailey, Duffy, Fryer, Pennington, Pownell and Wetzel have developed suggestions to assist educators in designing a successful implementation plan for using handheld technology in the classroom. Each of the researchers mention several key factors toward implementation of technology. (The presenter will now move to the next slide.)

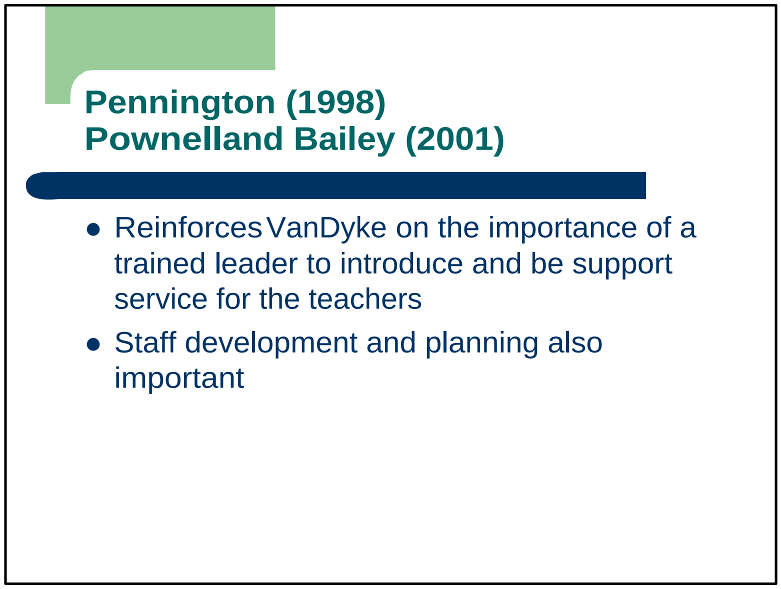


The study by Duffy (1980) reinforced the need for a trained supervisor to execute a successful implementation plan for handheld technology. The study took place in Columbus Public School System where three separate groups of teachers used calculators with their students with three different implementation strategies. One group used calculators with a student instructional package and had a trained supervisor; another group used just the calculators with no instructional package or supervisor; and a third group received the regular math instruction without calculators. At the conclusion of the study, the group with the complete calculator package with the trained supervisor showed the most improvement of students' performance in the classroom. Teacher training and supervision is an essential key factor when implementing handheld technology.

(Presenter will now move to the next slide.)

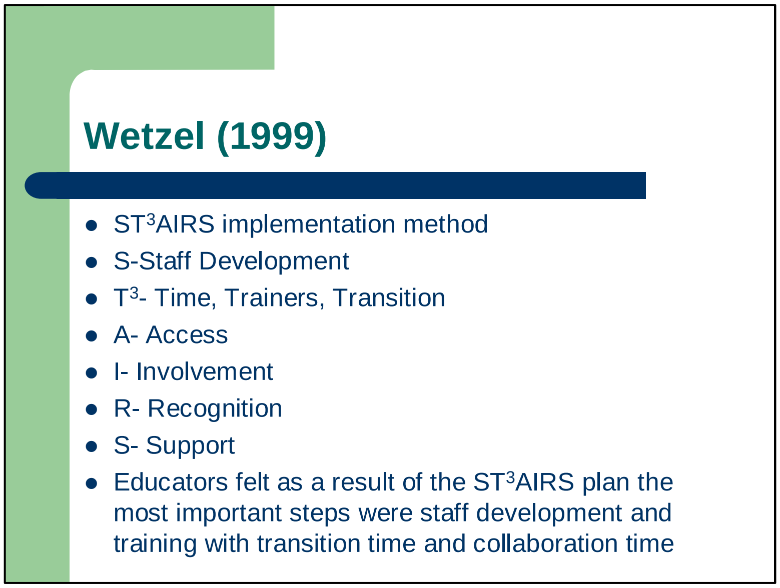


As mentioned, VanDyke (1996) conducted a study which included an implemention plan. VanDyke's plan was divided into waves or phases. The three phases consisted of an inservice for teachers in order to introduce the technology to them. The next phase was to instruct the teachers on effective methods to instruct the students when using computers and handheld technology. Finally, the last phase allowed teachers time to integrate computers and handheld technology into their curriculum. The success of this implementation plan was yet to be determined because of the short duration of the study. VanDyke believed that it takes two to three years in order to observe improvement in students' skills. (Presenter will move to the next slide.)



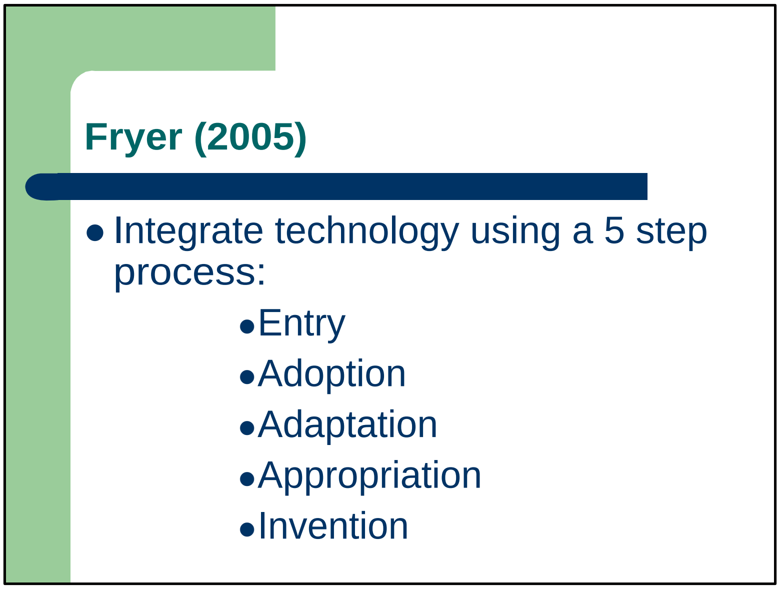
Pennington (1998), along with Pownell and Bailey (2001) reinforce VanDyke's findings concerning the importance of a trained leader to assist in implementation of technology. Pennington's study found out that students who had a trained teacher instructing them on the use of the calculator were more successful than those who did not.

Pownell and Bailey had a multistage plan that included a leader who introduces the technology and then acts as a mentor for the teachers to prevent them from becoming frustrated with the implementation process. Also included in the report from Pownell and Bailey was a successful implementation plan also included: (a) staff development (b) technology support (c) proper planning (d) health and safety of the student (e) ethics (f) evaluation of the curriculum yearly (g) securing a place that is safe (h) updating equipment and (i) keeping the technology affordable. Both studies agreed upon the importance of strong support services for the teacher as vital to the success of the implementation program. (Presenter will move to the next slide)

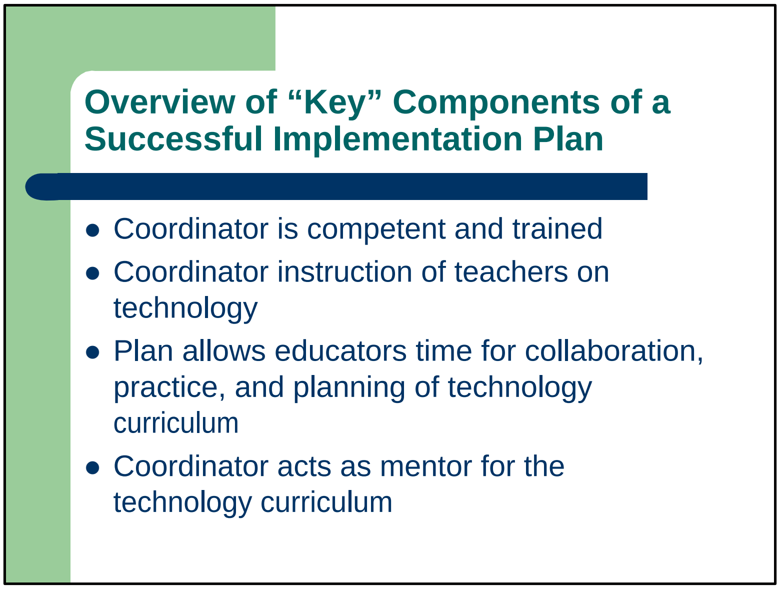


Similar to the other implementation plans previously mentioned, Wetzel's plan called the ST^{3}AIRS Model, is intended to make technology integration effective and long lasting. His multiple step process allows teachers guidance before, during, and after implementing new technology. The method begins with staff development, then, progresses to giving the teachers time to work with the new technology with trainers present, and includes then a transition period to integrate the technology into the classroom. The teachers had easy access to the technology and were involved in the implementation process. They received recognition for their efforts and were given professional support throughout the plan.

Upon completion of the plan, teachers felt that there were definite benefits to incorporating this technology plan into their curriculum. First, the teachers felt that they were given ample time to collaborate and explore the technology as a group without feeling pressured to get the technology into the classroom with students before they were ready. Wetzel's model was designed to involve the teachers in every phase of the implementation process. One conclusion drawn from the study was that collaboration was a key factor to teachers' success. Teachers, who met during formal and informal sessions, demonstrated their interest in the implementation process when they applied for grants to purchase additional CBL's and its probeware. Since the teachers had only one set of probeware during the study, they adjusted their science department budget to acquire additional probeware. (Presenter will now move to the next slide.)



Fryer (2005), like Wetzel (1999), adopted a plan of technology implementation utilizing a five step process including entry, adoption, adaptation, appropriation, and invention. Fryer emphasized the importance of teachers learning the technology in an atmosphere that is comfortable and non-threatening. Teachers will adopt the technology where they find it appropriate; the teachers and students then adapt the technology together. This model allows teachers to become creative and to invent new ways to incorporate the technology into their classroom. The technology can bring ways to use the technology using either a project-based curriculum or cooperative learning strategies. (The presenter will now move to the next slide.)

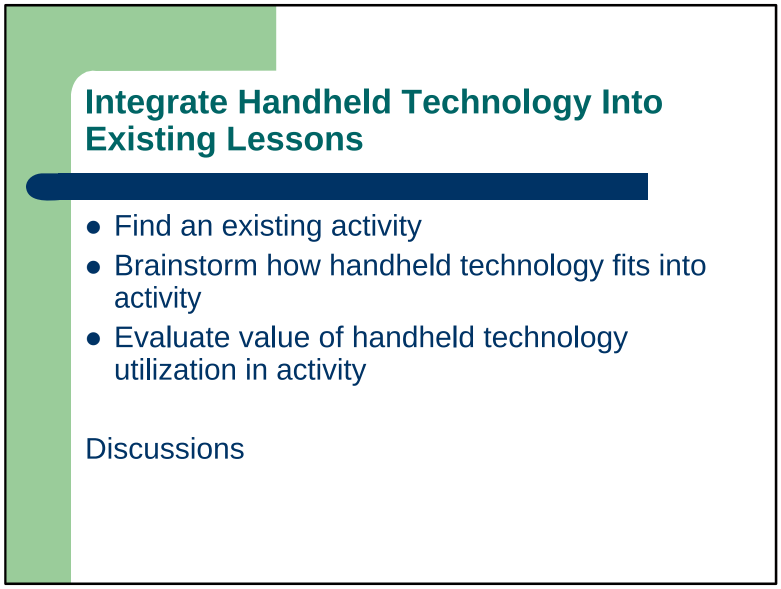


After a review all of the implementation plans, this researcher finds several key factors exist when technology is integrated into the classroom. A technology curriculum coordinator that is competent and resourceful is important for the success of the implementation process. The coordinator must not only be able to instruct teachers on the technology but be available during and after the integration to assist teachers with their needs.

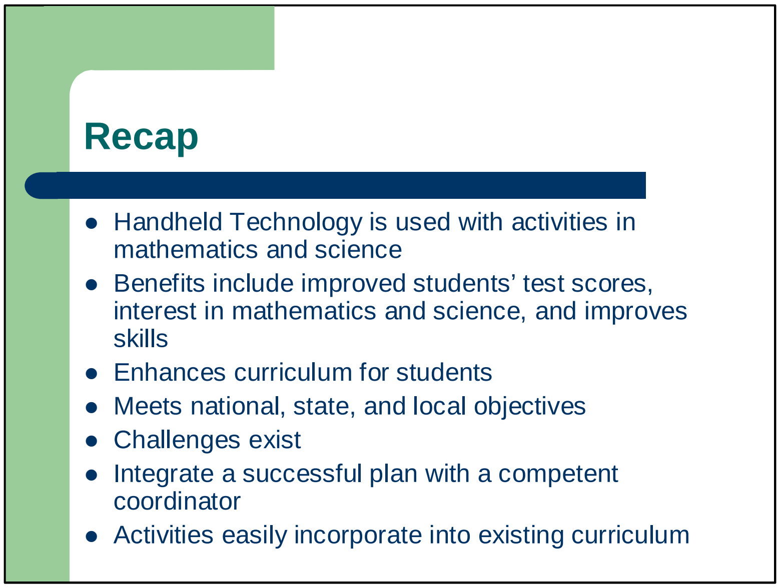
One of the most valuable components in the integration process is time. Educators need time to learn the technology and practice using the technology without and then with students. The educators also need time to plan appropriate instruction of the technology in the classroom. Careful review of the curriculum is important so teachers can evaluate whether the technology incorporated into a particular lesson is beneficial to the lesson. A successful implementation plan is important if it is going to be effective and long lasting. (The presenter will now move to the next slide.)

Now it is time to try using some handheld technology in activities for the classroom. All of these activities use a CBL, graphing calculator, and a probe. These activities can easily be incorporated into lessons in math and science classrooms. The jump activity allows students to measure their vertical jump using the light sensor probe when attached to the CBL and graphing calculator. Walk Like a Graph activity uses the motion sensor in order to walk like the example of a graph shown on the screen of the graphing calculator. Star Light Star Bright activity uses a light sensor to measure the brightness or intensity of different forms of light. Wind Chill activity uses the temperature probe and the CBL to measure the temperature of the atmosphere with and without wind. Finally, Color Absorption activity measures the temperature of a material in order to determine which color material absorbs the most heat or radiant energy.

All of the activities that use handheld technology follow the science process procedure in which students determine a problem, state a hypotheses, perform the experiment while following a procedure, collect data, and state a conclusion. The activities are located around the classroom in at five stations. Teachers can take their time working through the activities. While teachers actively participate in the activities, they can evaluate the need for the activity in their classroom and whether or not using the handheld technology would be of some value to them in the classroom with their students. (The presenter will move to the next slide.)



Once teachers have had appropriate time to work through the activities, the teachers then should discuss as a group the importance of using the handheld technology in the classroom. Also, teachers should brainstorm the use of handheld technology in their own classroom by choosing an activity that they already do and determining how they could incorporate the handheld technology into their own lesson. Finally, teachers should evaluate the benefits of handheld technology in their own classroom. Teachers should also state any concerns that they would have when implementing the technology into the classroom. (At this time presenter will move to the final slide)



In conclusion, the researcher will recap the information presented in the inservice. Handheld technology is used in the mathematics and science classrooms. Students benefit from the use of handheld technology because by using the technology test score improve and skills improve. Handheld technology enhances and enriches technology and the use can meet national, state, and local objectives. Teachers need to be aware of the challenges that exist. An implementation plan with a competent coordinator helps teachers in a school district integrate handheld technology with less reservations and stress.

Upon completion of the inservice, the presenter will ask the educators to complete an evaluation of the inservice. (See Appendix B).

Summary

Technological advances have been important in the world since the beginning of time. Man has been searching constantly for new and inventive ways to improve human life or make the world seem smaller. And nowhere has the interest in technology flourished more than with the youth. It would be impossible to define this generation of students without considering the role that radio, television, iPods, MP3 players, and Xbox play in their lives.

Technology that is small enough to fit into the hand is one current popular trend with today's youth, and educators who want to reach them might do well to consider how to implement such aids into the classroom to make it a more dynamic and effective learning environment. With guidance and encouragement, even the most reluctant educator can be taught how to use these aids to enhance classroom learning. It was with this goal in mind that this researcher decided to culminate the efforts of research in an inservice to meet the needs of the educator.

Presented in this inservice were numerous benefits of handheld technology. For instance, researchers including Siskind (1995), Wetzel (2001), Popejoy (2003) , Lentz and Boe (2004) reported improvements in the work of students using handheld technology. Both Wetzel (2001) and Kwon (2002) reported that the students' comprehension of science concepts enhanced their learning. Even though some researchers (McCluskey, 1994) emphasized that technology does not solve all the problems in classrooms today, in general, research verifies its importance in education as a motivating factor as well as a path to furthering critical thought. Despite challenges reported by Lentz and Boe (2004) and VanDyke (1996), research points educators who seek to enhance critical thinking skills toward vigorous implementation of technology in their classrooms.

Though the benefits are many, educators and administrators must recognize the necessity of careful planning to help ensure the successful execution of any educational endeavor, Duffy (1980), Pennington (1998), Pownell and Bailey (2001), VanDyke (1996) and Wetzel (2001) reported that a feasible technology implementation plan by school districts must exist if school districts desire technology education to be long lasting and pedagogical.

One of the most feasible technologies cited in research was the easily accessible and relatively economical handheld technology. Thus, educators in this project's inservice presentation were given an opportunity to experiment with this technology, familiarizing themselves with it while performing five activities using CBL and its probes. Next, the educators discussed how handheld technology could fit in with their existing lessons. Lastly, the educators filled out an evaluation on the inservice.

Chapter 5 will discuss the results of the evaluation on this project.

Chapter 5

Discussions

As technological advances continue to pervade everyone's world, even the most traditional classrooms today find it necessary to include a technology curriculum. Choosing the types of technology and the curriculum for the students is not an easy task for school district administrators and technology coordinators. But the challenge of incorporating useful, effective technology into lessons falls to the classroom teacher who must meet the educational requirements of the student. It seems that more and more information must be mastered by students in a minimal amount of time. The use of technology, mainly handhelds, can help to alleviate the burden of the classroom teacher by sharpening students' interest and motivation to learn new skills and concepts.

This project reviewed research on handheld technology, mainly CBL's, probes, and graphing calculators. The research concentrated on examining the effectiveness of using handheld technology in the classroom and exploring methods for efficient implementation. In reviewing research that addressed limitations of using the technology, this author discovered that, overall, research indicates that if educators are aware of the pitfalls with technology usage, technology used by students in the classroom can be effective.

This author presented information to math and science educators through a power point presentation which led these educators through research on handheld technology. Then, the author allowed the educators to manipulate the handheld technology by doing five activities that used CBL’s, graphing calculators, and several different probes. Finally, the author led the educators through a discussion on how handheld technology could fit into one of their existing lessons. An evaluation written by the participants provided the author with feedback on the inservice.

Limitations

Within the classroom, technology may be used either extensively or minimally depending upon the confidence and qualifications of the classroom teacher. Teachers attending the technology inservice presented by this author appreciated the research information, noting that a major appeal of handheld technology is the limited amount of space required to provide activities that will motivate the student. The participants felt that the research presented in the inservice provided information that would convince administrators of its usefulness and effectiveness in the classroom.

In practical application, the activities provided the teachers with ways they could incorporate the handhelds in the classroom. Educators felt that even though the inservice was of great benefit to them, limitations do exist.

The limitation which concerned the educators most was funding. Teachers wanted to know where funding for the technology and teacher training would come from. To alleviate this concern, perhaps this author could provide information on grant opportunities and other information showing where teachers can seek contributors for their technology in the classroom. Providing a pamphlet for the teachers to take with them at the conclusion of the inservice might be one way to address this concern.

The lessons included in the inservice were very helpful to the teachers, who said that they would be hesitant to use the equipment without working with it first. They readily acknowledged that application is what cements learning. The teachers enjoyed doing the activities so that they could see ways to incorporate the technology into their current curriculum. However, they felt that the lessons could have been more student-friendly by placing the standards at the end of the lesson or by presenting separate lessons that included both a teacher and a student guide.

A final main concern of the educators during this inservice was the troubleshooting and maintenance of the equipment. Educators do not want equipment failure and malfunctions to take up a large part of their teaching time. Teachers want to know whether they can troubleshoot problems and fix equipment easily. Teachers would need time to work with the equipment in order to become comfortable with it in front of students.

Further Study

This inservice focused on the subjects of math and science. Teachers who taught math and science were invited to attend. However, some teachers wondered if the technology could be expanded to other subject areas like language arts and social studies. Further study of additional subject areas could be helpful to participants in the inservice. Perhaps, one of the activities could have included other subject areas.

This inservice was limited to CBL's, graphing calculators, and their probes. It is important for educators to know what equipment is available and what programs go with the equipment. Teachers mentioned that iPOD's, PDA's, and podcasting are new forms of technology that they heard can be useful in the classroom. The author could have researched other forms of technology in order to discuss it as well as other types of equipment and programs available during a follow-up inservice.

Summary

As educators embark upon a new era in education, technology will play an extensive part in their curriculum. Exposing teachers to types of technology and to ways that technology can aid in student learning can provide teachers with information needed for a sound technology curriculum. By participating in this inservice, educators' exposure to handheld technology was heightened. This author met the goals of the inservice by introducing current research to teachers about handheld technology. The teachers were able to experiment with the handheld technology by doing the different activities using different probes. Finally, the teachers were able to brainstorm ideas on how the handheld technology could fit into their existing curriculum.

Many educators are aware that technology in the classroom benefits students. However, most teachers consider only computers as the primary means of technology implementation in the classroom. Teachers exposed to alternative forms of technology are able to incorporate technology without the use of a computer lab and without having to compete for lab time.

When technology is incorporated in the classroom, many benefits exist. The technology must meet the needs of the student, and the teacher must be confident and comfortable in the utilization of the technology. When these objectives are met, lessons become meaningful, long lasting, and effective for students.

REFERENCES

Aleahmad, T., & Slotta, J. (2002). *Integrating handheld technology and web-based science activities: New educational opportunities* (Report No. 143). (ERIC Document Reproduction Services No. ED 476 962)

Duffy, J. (1980). *Improving mathematics achievement of elementary students through the use of electronic hand calculators.* (ERIC Document Reproduction Services No. 209 263)

Fryer, W. (2005). *Tools for the TEKS: Integrating technology in the classroom.* Retrieved May 27, 2006, from://www.wtvi.com/teks/tia/overview/TIA_ Overview. html

Hedren, R. (1985). Hand-held calculator at the intermediate level. *Educational Studies in Mathematics, 16*(2), 163-179 (ERIC Document Reproduction Services No. EJ 320 390)

Kwon, O. N. (2002). The effects of calculator-based ranger activities on students' graphing ability. *School Science & Mathematics, 102*(2), 57-68. Retrieved January 3, 2006, from EBSCOhost database.

International Society for Technology in Education (2000). *Curriculum and content area standards; NETS for teachers.* 1-8 Retrieved January 1, 2006, from http://cnets .iste.org/currstands/cstands-netst.html

Lentz, K., & Boe, N. (2004). Implementing technology in elementary schools. *Technology and Children.* 9(2), 19-20 Retrieved March 12, 2006 from http://www.iteaconnect .org/TAA/LinkedFiles/Articles/TAC%20pdf/2004-05Volume9/T&Cdec04.vol9.2. pdf

McCluskey, L. (1994) Gresham's law, technology, and education. *Phi Delta Kappan, 75*(7), 1-4. Retrieved February 26, 2006, from EBSCOhost database.

National Research Council (1995). *Science content standards.* National Science Educationa Standards 1-10. Retrieved January 1, 2001, from http://newton.nap.ed u/html/nses/6a.html#sts

Pennington, R. (1998). *A study to determine the effect of instruction in effective use of a calculator on test scores of middle school students.* (Report No. 042). (ERIC Document Reproduction Services No. ED 434 030)

Popejoy, K. (2003). *Technology integration in an elementary science classroom: Its impact on teaching & learning* (Report No. 143). (ERIC Document Reproduction Services No. ED 475 477)

Pownell, D. & Bailey, G. (2001). Getting a handle on handhelds, what to consider before you introduce handheld computers in your classroom. *Electronic School*, 1-9. RetrievedJanuary 1, 2006 from http:www//electronic-school.com/2001/06/ 0601handhelds.html

Purcell, S. (2005). Educators' acceptance of and resistance to handheld technologies. *Curriculum & Teaching Dialogue, 7*(1/2), 79-93. Retrieved April 7, 2006, from EBSCOhost database.

Siskind, T (1995). The effect of calculator use on mathematics achievement for rural high school students. *The Rural Educator, 16*(2), 1-4. (ERIC Document Reproduction Services No. EJ 500 099)

Starr, S. (1989). *The effects of including calculators in the problem-solving instruction for low-income sixth-grade students*. (Report No. 143) (ERIC Document Reproduction Services No. ED 309 070)

U.S. Department of Education (2004). *A guide to education and no child left behind.* Retrieved March 12, 2006, from http://www.ed.gov/policy/elsec/leg /esea02/ pg1.html#sec1001 http://www.ed.gov/nclb /overview/intro/guide /guide.pdf

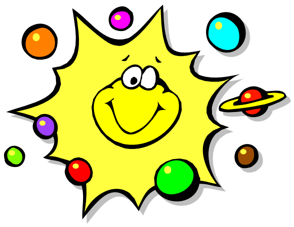
VanDyke, D. (1996). *Calculators in the mathematics classroom: A study of technology and affect.* Masters thesis, Pacific Lutheran University, Tacoma, WA.

Wetzel, D. R. (1999). *A model for successful implementation of instructional technology in science education* (Report No. 141) (ERIC Document Reproduction Services No. ED 436 409)

Wetzel, D. R. (2001). *A model for pedagogical and curricula transformation for the integration of technology in middle school science* (Report No. 143). (ERIC Document Reproduction Services No. ED 454 129)

APPENDIX A

Activities for Inservice



Star Light, Star Bright

PROBLEM: Does distance affect the brightness of a star as it is seen on Earth?

BACKGROUND: Some stars in the night sky seem to appear brighter than others. In fact the sun is the brightest star in our sky. Why is this so? Does distance make a difference? Are there brighter stars in the universe that are brighter than the sun? Research this information in your textbook or other references and proceed with this activity.

HYPOTHESIS:

NATIONAL STANDARDS:

SCIENCE CONTENT STANDARD A: As a result of activities in grades 5-8, all students should develop (a) Abilities necessary to do scientific inquiry, (b) Understandings about scientific inquiry.
SCIENCE CONTENT STANDARD D: As a result of their activities in grades 5-8, all students should develop an understanding of (a) Structure of the earth system, (b) Earth's history and, (c) Earth in the solar system.
MATH STANDARD: Instructional programs from pre-kindergarten through grade 12 should enable all students to (a) Recognize and use connections among mathematical ideas, (b) Understand how mathematical ideas interconnect and build on one another to produce a coherent whole, (c) Recognize and apply mathematics in contexts outside of mathematics
MATH STANDARD: Instructional programs from pre-kindergarten through grade 12 should enable all students all students should (a) understand numbers, ways of representing numbers, relationships among numbers, and number systems, (b) understand meanings of operations and how they relate to one another, (c) compute fluently and make reasonable estimates.
MATH STANDARD: Instructional programs from prekindergarten through grade 12 should enable all students to: (a) represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules, (b) relate and compare different forms of representation for a relationship, (c) identify functions as linear or nonlinear and contrast their properties from tables, graphs, or equations.

MATERIALS: flashlight, meter stick, CBL, and light sensor probe

PROCEDURE:

1. Place meter stick on the floor.
2. Put flashlight at the 10 cm mark.
3. Connect light sensor to CBL and place light sensor at the 0 cm mark and turn on the CBL and locate the reading on the CBL and record the reading in the data section.
4. Repeat the same procedure with the flashlight at the 30 cm, 50 cm, 90 cm, and 100 cm and record the readings in the data section.

DATA:

data chart	10 cm	30cm	50 cm	90cm	100 cm
light sensor					

GRAPH:

Light Intensity (mW/cm^2)

Distance on meter stick (cm)

CONCLUSION:

1. Is this experiment apparent or absolute magnitude? How do you know?

2. Was your hypothesis correct? How do you know?

3. Name one example that is mentioned in your reading where distance seems to affect the brightness of a star.

4. Name the constants. Name the variable.

EXTENSION:

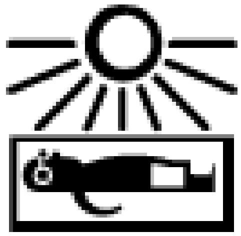
Use different types of lights.

REFERENCE:

Activity adapted from:

Volz, D. & Sapatka, S. (1997). *Physical Science with CBL*. Portland, Oregon: Vernier Software.

Randall, J. (1998). *Sensor Sensibility*. Berkley, CA: Key Curriculum Press.



Absorption and Radiant Energy

QUESTION: Does the color of a material affect the amount of absorbed radiant energy?

BACKGROUND: Wearing certain colors of clothing can make one feel hot or cool depending upon the color. Are certain colors more absorbent than others?

HYPOTHESIS:

____

____

NATIONAL STANDARDS:
SCIENCE CONTENT STANDARD F: As a result of activities in grades 5-8, all students should develop understanding of (a) Personal health, (b) Populations, resources, and environments, (c) Natural hazards, (d) Risks and benefits, (e) Science and technology in society.
SCIENCE CONTENT STANDARD B: As a result of their activities in grades 5-8, all students should develop an understanding of (a) Properties and changes of properties in matter, (b) Motions and forces and, (c) Transfer of energy.
MATH STANDARD: Instructional programs from prekindergarten through grade 12 should enable all students to (a) Recognize and use connections among mathematical ideas, (b) Understand how mathematical ideas interconnect and build on one another to produce a coherent whole, (c) Recognize and apply mathematics in contexts outside of mathematics
MATH STANDARD: Instructional programs from prekindergarten through grade 12 should enable all students to: (a) represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules, (b) relate and compare different forms of representation for a relationship, (c) identify functions as linear or nonlinear and contrast their properties from tables, graphs, or equations.

MATERIALS: 3 CBLs, 3 temperature probes, TI graphing calculator, heat lamp, stop watch or clock with a second hand, white construction paper, black construction paper, and a color of construction paper of your choice.

PROCEDURE:

1. Make pockets of the three colors of construction paper into a square 4 inches by 4 inches.

2. Place one temperature probe into the pocket of each of the three colors of construction paper and place under the heat lamps.
3. Attach one CBL to each temperature probe.
4. Turn on each CBL and take an initial reading after 30 seconds. RECORD on the data sheet.
5. Turn on heat lamps and take temperature readings every **minute for 15 minutes**. Record data on the data sheet.
6. When all the data is compiled, it is time to enter the data into the calculator.
7. **ENTER** The following information into the graphing calculator. **TIME** should go into **LIST 1. White construction paper** should go into **LIST 2**. **Black construction paper** should go into **LIST 3**. The **color of your choice** should go into **LIST 4**.
8. GRAPH the results on your calculator once you have set the parameters and turned on all the plots.
9. Compare the data.
10. Using the TI graph link and program, the graph can be printed out on a computer.

DATA:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
W															
B															
C															

CONCLUSION:

1. Calculate the temperature change, $\in t$, for each color; subtract the initial temperature from the final temperature. ($\in t=t_f-t_i$)

2. Which color had the larger temperature increase?

3. Which color had the smaller temperature increase?

4. From the data, which is the better color of material to wear in the summertime? Why do you think so?

5. What color is best to wear in the wintertime? Why do you think so?

6. What color do think would work best for solar collectors? Why do you think that this is the best color?

7. If you were an architect designing building for the southwestern United States, what colors would you choose for the buildings? Why would these colors be best for your buildings?

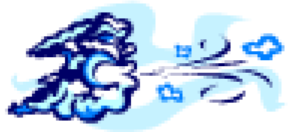
8. Name the variable. Name the constants.

EXTENSION:

Use more colors than just three. Use natural sunlight.

REFERENCE:

Activity adapted from Volz, D. & Sapatka, S. (1997). *Physical Science with CBL*. Portland, Oregon: Vernier Software.



Weather: COOL IT

QUESTION: Does wind change the temperature of the air?

BACKGROUND: Wind chill temperature is different that the temperature of the air. In the winter time people that live in cold regions pay close attention to the wind chill. Does wind make the air warmer or colder? Find out by doing the activity below.

HYPOTHESIS:

____

____

NATIONAL STANDARDS:

SCIENCE CONTENT STANDARD D: As a result of their activities in grades 5-8, all students should develop an understanding of (a) Structure of the earth system, (b) Earth's history
and, (c) Earth in the solar system.
SCIENCE CONTENT STANDARD A: As a result of activities in grades 5-8, all students should develop (a) Abilities necessary to do scientific inquiry, and (b)Understandings about scientific inquiry.
MATH STANDARD: Instructional programs from pre-kindergarten through grade 12 should enable all students to (a) Recognize and use connections among mathematical ideas, (b) Understand how mathematical ideas interconnect and build on one another to produce a coherent whole, (c) Recognize and apply mathematics in contexts outside of mathematics
MATH STANDARD: Instructional programs from pre-kindergarten through grade 12 should enable all students all students should (a) understand numbers, ways of representing numbers, relationships among numbers, and number systems, (b) understand meanings of operations and how they relate to one another, (c) compute fluently and make reasonable estimates.
MATH STANDARD: Instructional programs from prekindergarten through grade 12 should enable all students to: (a) represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules, (b) relate and compare different forms of representation for a relationship, (c) identify functions as linear or nonlinear and contrast their properties from tables, graphs, or equations.

Materials: CBL, temperature probe, cotton ball, paper plate, beaker of water, fan (made out of construction paper and fold accordion style)

Procedure:

1. Place several drops of water on the back of your hand and spread it around. What does it feel like?

2. Do the same as #1, only this time have your partner fan your hand with a piece of cardboard.
How does this time compare to the first?

What do you think caused this change?

3. Place the temperature probe into the CBL and turn on the CBL. Place the cotton ball in the beaker of water until moistened. Squeeze out the excess water and place cotton ball on top of the temperature probe.

4. Record the temperature every thirty seconds for three minutes. Record the data below.

WET COTTON BALL

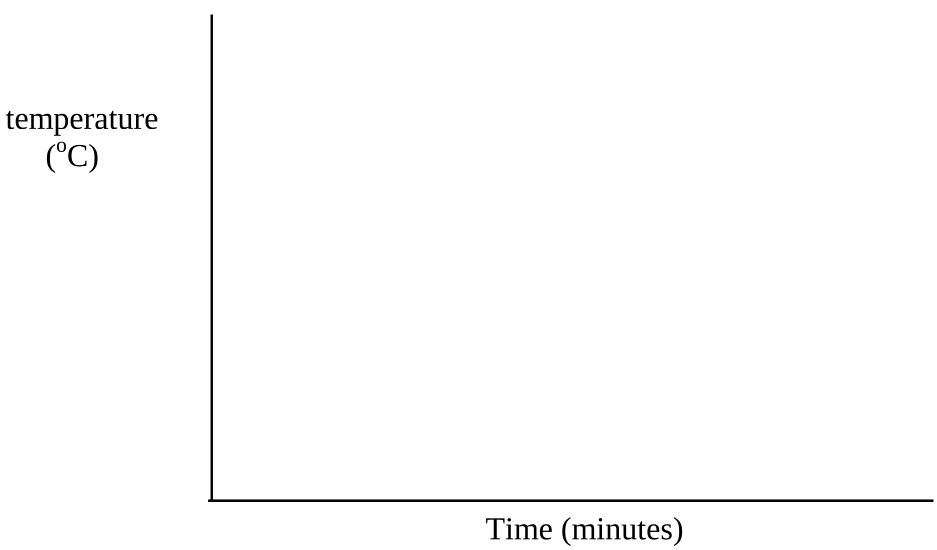
Time	Temperature
.5 min.	
1 min.	
1.5 min.	
2 min.	
2.5 min.	
3 min.	

5. Now take and re-wet the cotton ball and squeeze out the excess. Place the cotton ball on top of the temperature probe. Now fan the cotton ball for three minutes and record the temperatures every 30 seconds for three minutes. Write your temperatures in the table below.

FANNED COTTON BALL

Time	Temperature
.5 min.	
1 min.	
1.5 min.	
2 min.	
2.5 min.	
3 min.	

6. Graph your results. Put the temperature on the vertical axis and the time on the horizontal axis. Use a red color for the wet cotton ball and a blue color for the fanned cotton ball.



CONCLUSION:

1. How does the data compare?

2. What are the constants?

3. What is the variable?

4. Why is wind chill such a factor in the winter time?

5. What happens to the temperature in places like Chicago, Illinois in the summer time when you travel to the lake front and then travel to the suburbs?

EXTENSION:

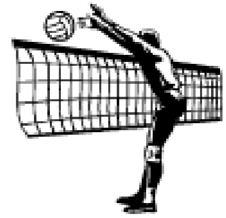
Record data from 6 different groups and graph the results. Students could repeat the experiment several more times.

REFERENCES:

Activity adapted from:

Feather, R. & Snyder, S. (1999). *Earth Science*. New York, New York: Glencoe/McGraw-Hill Companies, Inc.

JUMP!



QUESTION: How high can you jump?

BACKGROUND: In this activity you will find out your vertical jump. A vertical jump is important in most athletics. Once you know your vertical jump on Earth, how will it compare to other planets? You will calculate your vertical jump on other planets by doing the activity.

HYPOTHESIS:

NATIONAL STANDARDS:

SCIENCE CONTENT STANDARD A: As a result of activities in grades 5-8, all students should develop (a) Abilities necessary to do scientific inquiry, (b) Understandings about scientific inquiry.

SCIENCE CONTENT STANDARD D: As a result of their activities in grades 5-8, all students should develop an understanding of (a) Structure of the earth system, (b) Earth's history (c) Earth in the Solar System.

SCIENCE CONTENT STANDARD G: As a result of activities in grades 5-8, all students should develop understanding of (a) Science as a human endeavor (b) Nature of science, (c) History of science in the solar system.

MATH STANDARD: Instructional programs from pre-kindergarten through grade 12 should enable all students to (a) Recognize and use connections among mathematical ideas, (b) Understand how mathematical ideas interconnect and build on one another to produce a coherent whole, (c) Recognize and apply mathematics in contexts outside of mathematics

MATH STANDARD: Instructional programs from pre-kindergarten through grade 12 should enable all students all students should (a) understand numbers, ways of representing numbers, relationships among numbers, and number systems, (b) understand meanings of operations and how they relate to one another, (c) compute fluently and make reasonable estimates.

MATH STANDARD: Instructional programs from pre-kindergarten through grade 12 should enable all students to: (a) formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them, (b) develop and evaluate inferences and predictions that are based on data, (c) understand and apply basic concepts of probability.

MATERIALS: CBL, TI 82 or 83 Calculator with unit-to-unit cable, light probe, laser pointer, paper, masking tape, pencils, data sheets, ink pad.

PROCEDURE:

1. First let's predict your vertical jump and record your prediction on the table below. Then, measure your vertical jump without the CBL and compare the findings. Your teacher will take you to a designated area for measurement.

2. Next, get ink on your index finger and reach as far as you can on the paper without jumping or standing on your tip toes.

3. Next, jump up and make a mark with the ink.

4. When everyone in your group is finished, then take down the paper and measure the distance between your reach and your jump.

5. Record your vertical jump and the other group members on the data table below.

NAME	PREDICTION	ACTUAL VERTICAL JUMP

6. Next you need to set up the electronic vertical jump with the CBL. Place the laser pointer and the light sensor about three feet apart, so that the laser light is shining directly into the sensor.

7. In this activity you will stand so as to block the beam of laser light, then jump straight up and down, as directed. The time the beam is unblocked is detected by the CBL. Your jump height is computed by the calculator from your 'hang time'.

8. You will have an opportunity to jump more than once, but only your last attempt will be recorded in the data table.

9. RUN the **JUMP** program on the TI-82 or TI-83 calculator.

10. Follow the instructions on the calculator screen to complete the activity.

11. Complete the data table for you and your group members.

NAME	**VERTICAL JUMP**

12. Now use your data to complete the data for your vertical jump on other planets in the solar system.

object	formula to calculate height	vertical jump
Sun	divide by 30	
Mercury	multiply by 5 divide by 2	
Venus	multiply by 10 divide by 9	
Mars	multiply by 5 divide by 2	
Jupiter	multiply by 2 divide by 5	
Saturn	multiply by 7 divide by 8	
Uranus	multiply by 11 divide by 12	
Neptune	multiply by 5 divide by 7	
Pluto	multiply by 30	
Earth’s moon	multiply by 6	

CONCLUSION:

1. Compare your first two data tables, how close were your vertical jumps?

2. On which planet could you jump the highest?

3. On which planet could you jump the lowest?

4. Why don't you jump the same on each of the planets and the moon?

5. What seems to be the relationship between the jump and the planets?

6. Could you improve your vertical jump? If yes, how could you?

EXTENSIONS:

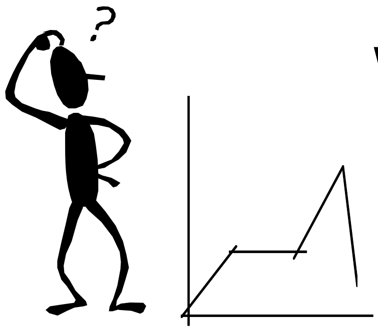
Compare and graph vertical jumps of the group or entire class. Use data in the TI-82 or 83 to teach maximum, minimum, range, mode, mean, and median.

REFERENCES:

Activity adapted from:

Brueningsen, C. & Bower, B (1994). *Real-World Math with the CBL System.* Urbana, IL: Texas Instrument Inc.

Astronomical Society of the Pacific (1995). *The universe at Your Fingertips: Am Astronomy Activity and Resource Notebook.* San Francisco, CA: Astronomical Society of the Pacific.



Walk Like A Graph!

QUESTION: How close can you get to walking like a graph?

BACKGROUND: In a graph there is an X and Y axis. The X axis is on the horizontal part of the graph and the Y axis is on the vertical part of the axis. By looking carefully at the relationship between the X and Y axis and the shape of the graph in each of the examples, students find it a challenge to match the graph.

HYPOTHESIS:

____

____

NATIONAL STANDARDS:

SCIENCE CONTENT STANDARD A: As a result of activities in grades 5-8, all students should develop (a) Abilities necessary to do scientific inquiry, (b) Understandings about scientific inquiry.
MATH STANDARD: Instructional programs from pre-kindergarten through grade 12 should enable all students to (a) Recognize and use connections among mathematical ideas, (b) Understand how mathematical ideas interconnect and build on one another to produce a coherent whole, (c) Recognize and apply mathematics in contexts outside of mathematics
MATH STANDARD: Instructional programs from pre-kindergarten through grade 12 should enable all students to (a) represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules, (b) relate and compare different forms of representation for a relationship, (c) identify functions as linear or nonlinear and contrast their properties from tables, graphs, or equations.

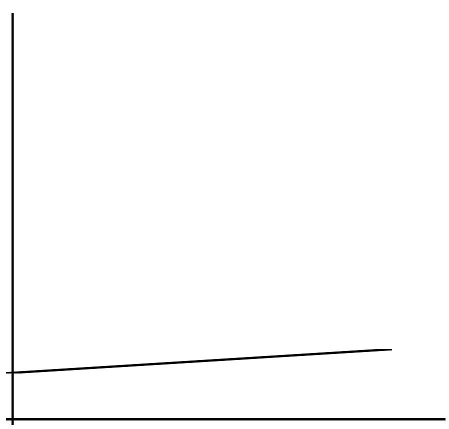
MATERIALS: motion detector, graphing calculator, CBL, desk or table, and a wide walkway marked at 1.5 feet away from the front of the motion detector, and 15 feet from the front of the motion detector.

PROCEDURE:

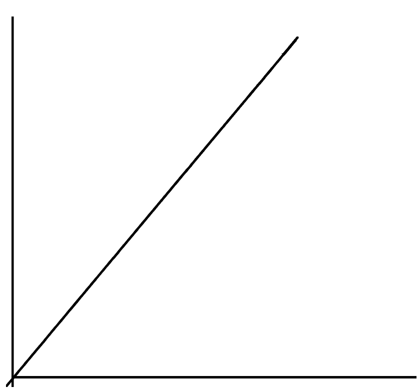
1. To create a graph, load the HIKER program into your calculator.
2. Connect the motion detector to the CBL by plugging the cord into the motion detector and into the "sonic" port on the left side of the CBL.
3. Connect the CBL and the calculator with the link cable.
4. Turn on the calculator and CBL. Do not press the mode button on the CBL>
5. Place the motion detector on the edge of a table so it will detect the movement of a student. The student must walk a straight line away from or toward the motion detector. Students must be 1.5 feet to 18 feet from the motion detector.
6. Press the PROG key and select HIKER.
7. Press ENTER to confirm HIKER.
8. Press ENTER to start the graphing. The calculator will display the graph as the student walks. The calculator displays the distance in feet and the time in seconds.

At the right of each graph, describe how a person must walk to match the original graph. You may consider breaking the graph into 2 or 3 pieces.

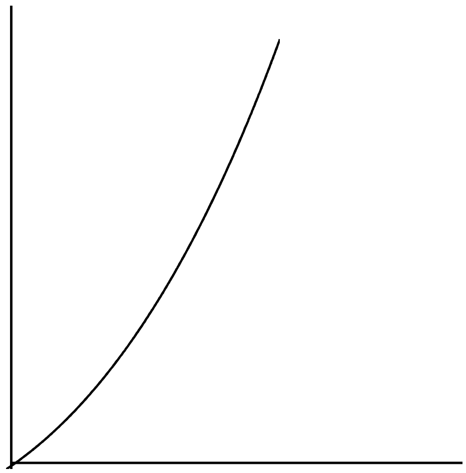
1. Person walking on a sidewalk 1.



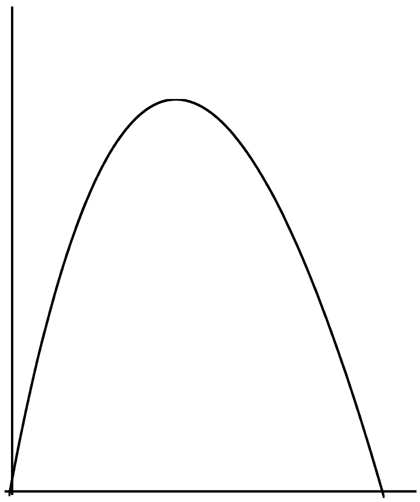
2. Car traveling down a highway 2.



3. Space Shuttle taking off 3.



4. Rock thrown into the air 4.



Finally, for more fun and practice, load the program DTMATCH into your calculator. The program and calculator will generate graphs for you to try to match. Just follow the directions on the calculator display.

CONCLUSION:

1. How close were you in the matches?

2. Did you improve every time you tried a new graph?

3. Draw a graph of a person walking his dog walked away from home then stopped for a bit at the park then walked home. Explain why you constructed the graph as you did.
.

EXTENSION:

Give students more examples and load in the program DTMATCH 2 for more practice.

REFERENCES:

Activity adapted from:

Brueningsen, C. & Bower, B (1994). *Real-World Math with the CBL System.*. Urbana, IL: Texas Instrument Inc.

Brueningsen, C., Brueningsen, E. & Bower, B (1997). *Explorations Math and Science in Motion: Activities for Middle School.* Austin, Texas, Texas Instrument Inc.

APPENDIX B

Evaluation for Inservice

Handheld Technology:
Overcoming Challenges and Implementation Seminar
Evaluation Form

1. Will the information on handheld technology help you when you return to your classroom? Why or why not?

2. Could you incorporate handheld technology into your already existing lessons? If so how? If not, what problems would prevent you from using it in the classroom?

3. What was more useful to you, the power point presentation on the research on handheld technology or the hands-on activities? Why?

4. What else would you would like to know more about in the area of handheld technology?

5. What additional information on handheld technology would make the presentation more helpful or useful to you?

APPENDIX C

Resources

Resources

Volz, D. & Sapatka, S. *Physical Science with CBL*.
Written by D. Volz, & S. Sapatka.

Sensor Sensibility.
Written by J. Randall.

Earth Science.
Written by R. Feather & S. Snyder.

Real-World Math with the CBL System.
Written by *C.* Brueningsen & B. Bower.

The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook.
Written by Astronomical Society of the Pacific.

Explorations Math and Science in Motion: Activities for Middle School.
Written by C. Brueningsen., E. Brueningsen & B. Bower.

National Science Education Standards.
Written by National Research Council.

Principles and Standards for School Mathematics.
Written by National Council of Teachers of Mathematics.