The Effects of Technology on Classroom Instruction

Malinda L. Wesley
St. John Fisher College

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Degree Name
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The Effects of Technology on Classroom Instruction

The research presented in this paper covers the effects of educational technology on student learning. It will examine whether the method used to present the material to the students determines the overall comprehension of the presented material. It has been shown that hands-on learning helps the students become engaged in the lessons and activities, which results in greater retention of the material. The use of technology in the classroom has been pushed to help keep the students up to date with the technological advancements of our society, and to ensure active participation within each activity. Instructional technology in the classroom could affect how engaged and involved the students are for each lesson, and perhaps affect their overall understanding of the material. This report will focus on the technology used as a tool for instruction and presentation of new material (Driscoll, 2002). This paper will explore the advantages of incorporating technology as well as multiple uses of technology in the classroom. In order for teachers to use technology in the classroom, it is important that the teachers know what resources are available to them, and it lies on the education programs as well as schools themselves to ensure that the teachers are well prepared and comfortable using such technology (Lonergan, 2001). In addition, the limitations are discussed; why it is that schools do not use technology more often to ensure the success of the students throughout their schooling career.
Literature Review

The use of technology in the classroom has been encouraged recently as society currently is a technologically driven world. Teachers use technology in a variety of ways from the presentation of the material, to reinforcement activities to show real life applications of the concepts taught in class. Before the teachers can use technology to increase the students' ability to understand the material, it is crucial that the teachers themselves understand the uses and advantages of different forms of technological apparatus.

The following will discuss sources that encourage the use of technology in the classroom and evidence showing the benefits technology has to the students. Different types of technology that can be used in the classroom will also be discussed, including instructional technologies as well as technology in a laboratory setting. In addition, the method schools use to prepare teachers for the incorporation of technology as well as the limitations of technology will be considered.

Why Use Technology?

The West Virginia Basic Skills study looked at the effects of student progress as computers were added in schools starting in the first grade (Barnett, 2003). As the students progressed up through the grades, they were given increased access to computers, and more computer knowledge was expected of them. To ensure that the students could be held accountable of this, more extensive teacher training was done. This also allowed the students to continually learn more information. As a result, students were tested in high school and the students who had access to computers at a younger age had larger gains throughout their schooling than students who did not have access to
computers. In addition, 11% of the gains were attributed to the computers (Barnett, 2003).

Project CHILD is another study that took place in Florida, where students used computers to learn information, and as a result they not only had higher test scores, they also had better discipline (Barnett, 2003). The discipline issue can be a result of the increased engagement of the students as technology is something that interests most students. In both of the previous studies, it is important to know that the teachers had extensive training, which may not be possible for some school districts.

Technology is a tool that can support instruction in the classroom. According to Driscoll (2002), there are four main principles describing how technology can assist with student learning in the classroom:

1. Learning occurs in context.
2. Learning is active.
3. Learning is social.
4. Learning is reflective

Understanding the main principals of how students learn, we can then implement technology to assist us within each of those domains. Technology can be used to connect students to reality (Van Tassel-Baska, 1998), which provides a solid foundation for their learning to begin (Schack, 2000). Students are presented with new material in many classes throughout the day. The ability of a teacher to be able to connect the new material with an already established frame of reference will make the recall of the material much easier. If students are able to connect the new information to their schema, then they are more likely to be able to solve more complex problems (Driscoll, 2002). Technology
used in the classroom can increase the students' higher-order thinking skills which has a direct correlation to their learning (Lonergan, 2001).

Students who are engaged and involved in their learning will retain more of the information. They will not only be able to learn the information required by the curriculum, but also be able to use and apply the ideas and concepts (Driscoll, 2002). The addition of technology into the classroom allows the students to become more involved in their learning. The use of technology integrated into activities also allows students to connect to the society we live in today (Lisowski, 1985). With the technology used in everyday life, teachers need to include the technology into the classroom to prepare the students for the real world. However, computer technology can not be the only tool used for students; it must be coupled with teacher interaction. McAndrews, Mullen, and Chadwick (2005) found that “Research shows that the use of computer technology, couples with face-to-face interaction with teachers, results in more student learning than face-to-face or computer-only instruction” (p. 13).

Groups of students often work on assignments together in the classroom. Collaboration allows for students to hear ideas and opinions other than their own (Driscoll, 2002). This allows them to receive feedback from their peers, personal reflections, and the teacher. This three point reflective technique allows for a greater understanding of the content being learned (Driscoll). When grouping students together, small grouping of mixed ability students allows for students to help their peers develop problem-solving skills (Schwartz, 1987). Technology can also play a role in reflective assistance with certain programs that allow immediate feedback on questions and sample problems. “Technology by itself does not guarantee learning. Rather, it is how teachers
and students use an available technology that determines whether transformative learning happens” (Driscoll, p. 4).

A classroom of students consists of multiple learning styles, and the use of technology can assist in addressing multiple learning styles simultaneously. McAndrews, Mullen, and Chadwick, (2005), stated that students are often motivated by the different uses of technology in the classroom aiding in the presentation of the material as well as the applications for activities. When we can address multiple learning styles such as, visual, auditory, and kinesthetic, the engagement of the students will increase and they will be able to further grasp the material. When the students are engaged in their activity they will retain more of the information and have a better understanding of how the concepts apply to the class.

*How Can Technology Be Used?*

Technology can be incorporated into the classroom as a method to teach the students the material, or to reinforce the material previously presented by the teacher (Barnett, 2003). There are a few levels of technological use in the classroom, traditional technology, instructional technology, and the use of technology to teach new educational concepts (Leider, 1998). Most teachers already use traditional technology requiring students to word process their papers, and using the internet as a research tool for projects. Instructional technology is used by some teachers to present the material in a much more engaging manner for the students. When the students are engaged, they are more likely to grasp the material. Finally, using technology to teach new educational material is an aspect that even fewer teachers are using. There are programs designed specifically to introduce new concepts to the students, some even have individualized
assessments worked into them so that the students receive immediate feedback on their progress.

A survey of the use of technology was completed in Florida by Barron, Kemker, Harmes, & Kalaydjian (2003), and of the teachers that responded, 50% use technology in the classroom as a communication tool. Others use it as a tool integrated into the curriculum in order to complete projects or solve problems; in both situations, science teachers are the ones who use the technology most frequently. “When students are able to choose and use technology tools to help themselves obtain information, analyze, synthesize, and assimilate it, and then present it in an acceptable manner, then technology integration has taken place” (Kemker, Harmes, & Kalaydjian, 2003). This goal was set for teachers by the U.S. Department of Education in 2002, to increase the use of technology in the classroom as a way to communicate with students as well as a way for students to complete assignments.

In 2001 state educational agencies were required by the Enhancing Education through Technology Act to “assist every student in crossing the digital divide by ensuring that every student is technology literate by the time the student finishes the eighth grade, regardless of the student’s race, ethnicity, gender, family income, geographic location, or disability” (Kemker, Harmes, & Kalaydjian, 2003). This was a standard that was set as a result of the No Child Left Behind Act and it has been encouraged throughout schools nation wide. The survey done by Kemker, Harmes, & Kalaydjian showed that Computer and Business teachers use computers over 70% of the time, while English and Elementary teachers use them about 25% of the time and Science, Social Studies and Math use computers less than 20% of the time. As a result of this survey, technology has
been encouraged to increase the amount of time that students are using computers to make them more technologically literate.

Videodiscs are another educational resource that can be used in the classroom. They can be used individually to model some of the unsafe demonstrations that occur in the science classroom (McLean, 1985). Videodiscs also provide the students with examples of how the science concepts relate to real issues (Murphy, 1996). Using the interactive technology with the students will allow a more inquiry based learning experience for the students (Haury, 1993). This is a visual tool that also helps address the different learning styles in the classroom.

Inquiry based learning is an effective way to present material. Through inquiry based learning students are the ones directing their learning; they ask the questions and solve the problems presented to them. Data-acquisition technology assists in the capturing of data so that the students are concentrating on the information gathered, rather than the technique of acquiring the data (Millar, 2005).

Sprague (2000) commented on the many uses of technology in the classroom, including the wealth of resources on the internet for the teacher. There are lesson plans and teaching material in multiple subjects that a teacher can use and incorporate into the classroom (2000). It can be overwhelming to see all of the resources and filter through them to find the useful information, but careful bookmarking skills will make the internet search much more manageable (Mardis, 2001). When a teacher looks on the internet, some of the resources are helpful when planning a lesson; while, others provide lessons where the students are able to learn through an internet activity. It is important for the teachers to incorporate some of the internet resources for the students. Students can
benefit from using the World Wide Web to gather information and further explore major concepts taught in the classroom (VanFossen, 1998). This will lead to a deeper understanding of the material as it will be viewed from different points of view, as it will also teach the students important skills on searching websites for credible, reliable sources.

PowerPoint is another presentation method of technology that can be used to present the material to students. It is helpful because it allows the students to have an accurate set of notes and ensures that the information they obtain is accurately recorded as opposed to a lecture situation (Cox & Rogers, 2005). With a PowerPoint presentation the author is able to import graphics, pictures, and add features such as sound effects, music, and videos to enhance the presentation (Miltenoff & Rodgers, 2003). Another feature of PowerPoint presentations is that they can be used to make posters or scrapbooks in addition to presentations (Newbrey & Baltezore, 2006) & (Carter, Sumrall & Curry, 2006). This is a feature that the students are able to take advantage of in terms of a project, and it enables them to become familiar with the technology that is so widely used today.

PowerPoint presentations can be useful as they attract the viewers to pay attention and have responded positively, although they can create an atmosphere that encourages students to drift off as the lights are dimmed and the students are more passive in this type of note taking (Crow, 2005). Although there are some critics, Miltenoff and Rodgers, 2003, conducted a pilot test of 16- to 18-year-old students in Minnesota and had comments that fell into the following categories:

- Loved the interactivity.
• Fun and entertaining.

• Easy to use.

• Really liked the videos. We rarely get to see what we learn about.

• A great asset to one who is researching or just curious.

Students may enjoy the PowerPoint presentations, but it is important to be sure that they are still just as involved in the process of their learning. It is important to ask questions and involve them into the presentation so that they are attentive and engaged. Another way that they can be used to do just that is to incorporate PowerPoint presentations into an inquiry unit (Stemadel, 2004). Present little bits of information at a time so that the students understand the problem and are able to design a solution. This will engage them in the beginning so that they are more involved in the entire process.

Assistive technology can be used for students with individualized education plans (IEP) to address some of the modifications to meet the students needs (Warger, 1998). The TECH Point system is a program designed by Gayl Bowser and Penny Reed which helps identify points where assistive technology may be a useful in a student's IEP. The TECH Points that encourage students to use assistive technology are:

1. Initial referral question.

2. Evaluation questions.

3. Extended assessment questions.

4. Plan development questions.

5. Implementation questions.

6. Periodic review questions.
By using assistive technology during these points a student will be able to tailor the activities to ensure student success. When technology is added to question the student periodically throughout their learning process, it will help address any misconceptions as soon as they arise.

In addition to using technology to address the needs of students with IEP’s, technology can be used to address the needs of the gifted students as well. In the science classroom, students often perform and analyze laboratory activities. Further exploration may occur if the gifted students use graphing calculators or graphing programs on the computer to further analyze the data to determine trends not necessarily discussed during traditional analysis (Johnson, 2000). The extension of the exercises in the classroom for the gifted students allow for further success in their post high school education.

The Oshkosh Area School District evaluated the Science and Technology for Children curriculum (Lattery, Lemberger, & Herzog, 2002). Half of the students learned from the original curriculum in the district, while half of the students used the Science and Technology for Children curriculum. The main focus questions driving the experiment were, what gains in student achievement on standardized tests can be expected in the first year or so of implementation and what types of learning can be expected? This experiment concluded that both the control as well as the treatment groups experienced mild gains, and thus no significant improvement can be concluded based on the Science and Technology for Children curriculum. In addition, students’ attitudes toward science either remained the same or declined as a result of this curriculum. Based on this experiment, it shows that certain curriculum programs that have been designed and attempted may need some revisions before they are ready for a
wide range of implementation. Technology can be useful, but when it changes students’ attitudes toward science in general, adjustments need to be made to ensure success.

Teacher Preparation for the Incorporation of Technology

Many teachers do not incorporate technology into their classroom because they simply do not know how. According to Lonergan, (2001), teachers currently in certification programs need to see the technology used so that they have a background of how it can be implemented. In addition, current teachers need assistance during professional development days. Teacher education programs should be modeling the use of instructional technology throughout the program, and also allow teachers to become familiar with, and use the technology during their field experiences (Lonergan). The increased exposure of the teachers to the different technological opportunities will allow for a greater probability that the teacher will be able to use it in their classroom. In addition, if a student teacher is paired with an experienced teacher who continually uses technology in the classroom, then there is a greater chance that the information coming from the cooperating teacher will be beneficial. School districts have their own responsibility to encourage student teachers to use instructional technology in the classroom. They need to make student teachers in the district aware of the technology available to them, and encourage its use during their field experience. Schools should also make sure that they concentrate on using the technology for instruction as well as student activities (Lonergan, 2001).

In-service teachers are at more of a disadvantage because most did not use computers during their school careers. It was recommended that the following steps are taken to educate the in-service teachers on a regular basis (Lonergan, 2001):
1. “Every state should develop standards for effective continuing education on integrating technology into the curriculum.

2. Schools and districts should develop technology plans that include professional development in the use of technology and proficiency standards.

3. Every teacher and administrator should have access to information technology.

4. Resources for technology-related professional development should be increased.

5. Every professional development program should integrate technology into its curriculum” (p. 3).

Schools that are able to successfully incorporate technology into their professional development programs also need to include follow up activities and monitor the integration of the technology into the classroom and provide additional assistance where necessary (Kagima & Hausafus, 2001). With the new technology that is developing, and presented to the teachers, it is up to the teachers themselves to incorporate it into their classroom (Kagima & Husafus).

Limitations of Technology

According to Abdal-Haqq, (1995) the main reason teachers lack the technology use in their classroom is a lack of training and inadequate access to the technology. One problem that also occurs is that teachers use computers for word processing and drills. Computers have a much wider span of capabilities that can assist students in their education and it is important that teachers are aware of the more sophisticated aspects. The more we use the computers to assist in the teaching of classroom material, the more
developed the students' higher-order thinking and problem-solving skills will be (Abdal-Haqq, 1995).

It is difficult for colleges to keep up to date with the technological advancements that occur so frequently, let alone high schools. Computers have a six year life-span, before they become outdated, however, after about three years they often need upgrades as well (McKinney, 1996). Schools also need to provide enough computers for the increasing number of students and faculty as well as provide the training necessary so that the teachers are able to use the technology to help with their instruction (McKinney, 1996). Although there are some issues holding back some schools from advancing fully into the new wave of technology, McKinney stated “Students and faculty must try to remain abreast of the technology in order to maintain their competitiveness in the job market” (1996, p. 4). Abdal-Haqq states that in addition to the lack of funds that could inhibit the technological capabilities of a school, it is also difficult to incorporate technology into the curriculum because of the expectations of the students and parents, as well as the demands from the professional associations that mandate educational requirements (1995).

The literature presented supports the inclusion of technology into the curriculum in various methods. It is important to include the technology because it better prepares students in their post-high school life because technology is highly used in the world today. Technology also helps students gain more knowledge throughout their high school career and it can be attributed to computers (Barnett, 2003). In addition, students will not only be able to learn the information required by the curriculum, but also be able to use
and apply the ideas and concepts (Driscoll, 2002), which is a skill that will be useful and beneficial throughout their life.

Technology can be incorporated in a variety of ways, allowing the students to learn through different methods of technology or use the technology themselves to enhance their learning. Inquiry based learning provides another method of technological incorporation where students can be presented with the problem through various means of technology that will engage them fully (Millar, 2005).

PowerPoint presentations are a very powerful tool that can involve students so that they are more active and involved in their learning. It is easier to involve students into a presentation generated through the computer than it is to incorporate involvement through lecture based instruction.

In order for the teachers to begin using this technology and sharing it with their students it is important that they understand its capabilities. Part of that involves each school district running programs to inform the teachers of how to use computers for instruction, calculators for analysis, and involving the students throughout the process. Some teachers are at a disadvantage because they did not use computers during their school careers and thus are not as knowledgeable as the newer teachers (Lonergan, 2001). Some districts incorporate technological application into their professional development programs which allows for easy access to many teachers at a time (Kagima & Hausafus, 2001).

Although there are many advantages to incorporate technology into the classroom, there are some downfalls due to the expense of the technology itself as well as the cost of training the educators (Abdal-Haqq, 1995). Once a school is able to become
connected and have all of the necessary pieces of equipment, it is sometimes just in time to update everything (McKinney, 1996).
Methodology

This project explored the uses of technology in the classroom with a focus on instructional technology. The observations were done at Olentangy Liberty High School, which is a suburban school district of Columbus, Ohio. Data was collected from students at Olentangy Liberty High School to determine the effects of technology on classroom instruction.

Participants:

The high school has approximately 1500 students and is located in a very affluent area outside of Columbus. The students who attend Olentangy Liberty High School consistently score above average on nation-wide achievement tests and the vast majority of them continue on to post high school education programs.

The students who participated in this study included 130 9th grade students and one 12th grade student, who were all enrolled in Physical Science. They were already enrolled in six different classes of various class sizes and the class meeting times were spread out throughout the day. The students, both male and female, range in age from 14 to 17 years of age, and their race is broken down as follows: 90% Caucasian, four percent African American, three percent Asian, and three percent other ethnicities. In addition, four percent of the students were English Language Learners as they have lived in this country for less than three years and English was their second language. Six percent of the students had Individualized Education Plans (IEP) and the students with an IEP were in mixed into three of the six classes.

Materials:
Data was gathered using multiple methods in order to ensure triangulation of data to make it more reliable. Data was collected using pre-tests and post-tests to determine their academic progress, tickets out the door to quickly address any misconceptions, and observations during activities to assess their ability to convey the material to their peers.

*Pre-test and Post-test*

In a regular chapter, students were given pre-tests to determine their academic ability before beginning a chapter, and then quizzes and chapter tests to assess the content knowledge gained with each chapter of material presented. The academic progress of each class was calculated by the percentage increase from the pre-test to the quizzes, and eventually the chapter test.

*Ticket out the Door*

Students frequently had a ticket out the door which was used to note any misconceptions or areas of confusion based on the content presented in the lesson. The ticket out the door was not graded for accuracy, but used as a way for the students to communicate to the teacher whether the content was being received and note any areas of confusion. The tickets out the door usually consisted of three to five questions related to the content, some short answer questions for the students to explain a process covered in class, and an area to note any topics where clarification was necessary.

*Observations*

Throughout the year in a science class, students performed hands-on laboratory experiments and group activities to reinforce the concepts taught in class. During these times, observations were made regarding the discussions students had with each other and actions they took throughout the activity. These observations noted students
displaying their understanding of the material or confusion of the concepts addressed in
the activity.

Procedure

A one week study took place to gather data from students. Students were learning
about introductory physics material and had previously learned about the mathematics
behind the physics concepts. Each class is 45 minutes long and the typical class begins
with bell work, leads into the lesson of the day, and frequently ends with a ticket out the
doors. The lesson of the day in the science classroom varied from notes, to hands-on
activities, to laboratory experiments for the students to explore the scientific concepts.

In this study, the material presented to each of the six classes was identical. Every
student was given a set of guided notes based on the presentation of the material;
however, three different levels of technology were used to present the material to
different classes. The three different levels of instructional technology are listed below.

- **Level 1** – Lecture only
- **Level 2** – Use of the overhead and white board
- **Level 3** – PowerPoint Presentations

Level 1 was the control, no technology was used, just a standard lecture for the
students to follow along and complete the notes. Level 2 allowed the students a visual aid
to observe and follow along with as they completed their notes. Level 3 allowed students
to follow along to a presentation that had background colors, unique fonts and images to
enhance the presentation.

In addition to adding different levels of technology with classroom instruction, there
were five different levels of technology that were used to collect and analyze the data in
the laboratory experiment. The five levels of technology incorporation for the data collection and analysis of the laboratory experiments include:

- **Level 1**
  - Collected data by hand using stopwatches and meter sticks
  - Analyzed data by hand to make graphs and draw best fit lines.

- **Level 2**
  - Collected data by hand using stopwatches and meter sticks
  - Analyzed data using calculators to make the graphs and best fit lines

- **Level 3**
  - Collected data by hand using stopwatches and meter sticks
  - Analyzed data using computers to make the graphs and best fit lines

- **Level 4**
  - Collected data using Vernier Technology
  - Analyzed data using calculators to make the graphs and best fit lines

- **Level 5**
  - Collected data using Vernier Technology
  - Analyzed data using computers to make the graphs and best fit lines

The first level was the control, where no technology is used either in the data collection or the data analysis. Levels two and three incorporated technology, calculators for level two and computers for level three, to be used during data analysis, however, data collection was done by hand. Levels four and five incorporated technology in both the data collection and the data analysis sections of the lab. Level four will have access to
calculators in both the data collection and the data analysis, while Level five will have access to computers in both the data collection and the data analysis.

There were six classes that met throughout the day, Class A, Class B, Class C, Class D, Class E, and Class F. Each class’s overall Grade Point Average (GPA) provided data to rank their overall academic performance. The classes were ranked, Class D, Class B, Class F, Class A, Class E, and Class C. This new order was used to determine which classes would receive which levels of technology instruction. The list below shows which levels of instruction each class received:

- Class A
  - Instructional Technology – Level 1
  - Laboratory Technology – Level 1

- Class B
  - Instructional Technology – Level 3
  - Laboratory Technology – Level 5

- Class C
  - Instructional Technology – Level 2
  - Laboratory Technology – Level 3

- Class D
  - Instructional Technology – Level 2
  - Laboratory Technology – Level 2

- Class E
  - Instructional Technology – Level 3
  - Laboratory Technology – Level 4
Class F

- Instructional Technology – Level 1
- Laboratory Technology – Level 1

The content being taught and the assessments were as follows:

Lesson 1

- Bell work - Pretest
  - The initial assessment for the section on Acids and Bases
- Introduction to the new material
  - Content presented in note-taking format
  - Acids vs. Bases and the pH scale
- Ticket out the Door
  - 3 pH problems to complete
  - 2 short answer problems requiring them to explain acids and bases
  - 1 area of confusion
  - Used as an assessment to address any misconceptions from the daily lesson
- Homework – worksheet on acids, bases and the pH scale.

Lesson 2

- Bell work – Questions addressing areas of confusion from previous day
- Activity reinforcing concepts taught in Lesson 1
  - Acids and Bases Introduction Lab
  - Content taught allowing students to explore the content further
Observations made based on interactions between students throughout the activity

- No Ticket out the Door today

- Homework – summary questions regarding in-class activity

Lesson 3

- Bell work – Questions involving common household acids and bases

- New material
  - Elaboration of material taught in Lesson 1
  - Content presented in note-taking format
  - pH indicators, how to recognize and test for acids and bases

- Ticket out the Door
  - 3 questions regarding different indicators
  - 2 areas of confidence of the new material
  - 1 area of weakness/need for clarification from new material

- Homework – read through the lab in lesson 4

Lesson 4

- Bell work – pre-lab quiz
  - Ensures students are prepared for the upcoming lab as well as understand the purpose and procedure

- Lab – Acid and Base Indicator Lab
  - Students explore content taught in class through a laboratory experiment
  - Students gather the data using different levels of technology
Observations made based on interactions between students throughout the lab activity

- **Ticket out the Door**
  - 3 questions about data collected in the lab
  - 2 short answer questions about data analysis (to be completed in Lesson 5)
  - 1 area in need of clarification

- **Homework** — none, data analysis will continue tomorrow

**Lesson 5**

- **Bell work** — lab summary questions
- **Lab**
  - finish data analysis using different levels of technology
- **Homework** — full lab report for Acid and Base Indicator Lab

**Lesson 6**

- **Quiz**
  - Summary of content learned in the previous five lessons

- **Begin next section**

Based on the lesson plans presented above, students will have multiple opportunities to be presented with new content and reinforce the concepts taught in class. There are also opportunities to check for understanding and clarify the misconceptions and confusions. In addition, during the bell work, students were able to ask questions about the homework or the content in general.
Results

At the completion of this experiment data was collected from student scores on the pre-test, post-test, and two lab activities. In addition, students completed questionnaires discussing their overall satisfaction on how the unit was taught along with their understanding of technology before and after this unit. Throughout the laboratory experiments observations were made of student interactions and student reactions to the technology used in the data collection and data analysis phases.

Each class was given a pre-test to assess their knowledge of science before beginning the unit. The pre-test (Appendix A) assessed the information that students should have known prior to beginning the unit; it is the information background that each student built upon as they furthered their studies. The post-test, Appendix D, was their final assessment of the unit, and it showed the growth of the classes from the beginning to the end of the unit. Table 1 shows the raw data indicating how each class performed on each of the four assessments throughout the unit. Also included in Table 1 are the instructional technology level and the laboratory technology level that each class was treated with and allowed to use. The final column in Table 1 shows the percent increase of each class from the pre-test to the post-test.

The information in Figure 1 shows the scores on the pre-test and the post-test depending upon the instructional technology level used. Each class did improve from the pre-test to the post test and Figure 2 shows the percentage increase from the pre-test to the post-test. Both figures also are sorted based on the instructional technology level, and Figure 2 shows that, in fact, the classes that had an instructional technology level of three, had a 10% increase or higher. The classes that had an instructional technology level of
two were around a four and a half percent increase while the classes that had an instructional technology level of one had less than a four percent increase between the pre-test and the post-test.

There were two labs that were conducted throughout this unit, the Acid and Base Lab (Appendix B) and the Acid and Base Indicator Lab (Appendix C). For both of the labs some classes were allowed to use Vernier pH probes and computers for data collection, and either calculators or computers for analysis, while other classes continued complete their analysis by hand. Figure 3 shows the lab scores from each of the classes as it is sorted by the laboratory technology level used. Both classes at a laboratory technology level of 1 were at least ten points below any of the other classes with higher laboratory technology levels. Classes that used any technology either in data collection or in data analysis, (laboratory technology level of two through level five) scored significantly higher on the Acid and Base Lab, as well as the Acid and Base Indicator Lab.

At the completion of this unit, the students completed a questionnaire about their overall satisfaction with their learning and comprehension of the material. The students were overall satisfied with their learning, and some students commented that “acids and bases are fun, we have learned about them before, and it was neat testing the pH of the things in my house.” The Acid and Base Unit is one that the students have studied, but we extended the information further, and analyzed the pH scale, something new for the students, and when asked about that, one student commented “I thought it was cool that ammonia is one million times stronger [of a base] than antacids.” In addition to assessing their overall engagement into the unit, the questionnaire asked the students about how the
technology helped them collect their data, slowed them down or confused their understanding of the material. Some of the responses from the classes who didn’t use the technology included “I thought it was hard matching up the pH papers, because sometimes it was in between numbers and we had to guess the number and sometimes we guessed wrong,” “I liked the pH papers because it reminded me of art class, and I like the colors.” Students who were allowed to use the Vernier pH probes commented “I thought the pH probes made it easier to test the pH value, we didn’t need to do anything because it just told us what the pH was,” “I liked the Vernier pH probes so that we didn’t have to match up a color on the pH paper.”

For the data analysis students either graphed the pH scales by hand, using the calculator, or using a computer. Again, students were asked how the technology they used affected their lab. Students who graphed it by hand commented “I am used to graphing results by hand because that is what we have one in math and science class, sometimes I just get confused on what to put on what axis,” “I don’t like graphing by hand because that is what we do in math class.” Students who used calculators commented “I have graphed on the calculators in math class, so it was OK, but we don’t do it often in science, so it is something I would have to get used to,” “I don’t like graphing the results, because it is hard to line up all of the data [points] so the calculator made the graph easier to read.” Finally, the students who used the computers for the data analysis mentioned that “the computers were nice; I think that if I had more practice then I would have been able to do it quicker.” “the computers were confusing; there are a lot of steps in making a graph with the data.”
The third piece of data collected was from teacher observations, this allowed for a triangulation of data and it occurred mainly during the instructional notes and the laboratory experiments. It was observed that the classes who were using the traditional lecture method of instruction were taking the notes well, however, often began talking or becoming distracted after the information was written down in their notes. In addition, students frequently were asking for the information to be repeated in order to ensure that their notes were accurate.

For the classes who were using the overhead transparency to take notes were frequently asking for clarification as to what the information said on the overhead. Handwriting is an issue when it comes to written overheads or transparencies that are a combination of typed information and handwritten information. In addition, students didn't appear to be completely engaged in the lesson.

Finally, the group of classes that were shown the PowerPoint presentations as the method of note taking had a different atmosphere in the classroom during notes. The students did seem to be engaged and the questions they were asking were related to the content, not clarification about the information they needed to copy down to ensure accuracy of their notes. The students were not distracted after they were done copying down the notes and did not begin any side conversations.

Throughout the lab experiments there was not as big of a difference between the classes as noted during the note taking sessions. The technology did make the data collection and the data analysis go much smoother once they got started, however, it did take a little longer in order to begin the lab. Other comments I overheard from the students included “I am not sure what the information means,” “where did the data go
after we put the probe in the liquid?" This led to some areas of confusion once the data
was collected, however once they understood the equipment, I overheard the following
comments, “wow, this is really fast,” “I can’t believe we don’t need to make a graph.”

The students who were able to successfully collect data from the laboratory
experiments and graph the information on a calculator or the computer also ensured that
the information was graphed properly so that the analysis was based data presently
correctly. The students who graphed information by hand sometimes had the information
on the opposite axis, incorrectly plotted the information, or weren’t careful enough to all
of the details. These were mistakes that were eliminated by using calculators or
computers to plot the information.
Table 1 Raw Data from the Acid and Base Unit

<table>
<thead>
<tr>
<th>Class</th>
<th>Instructional Level</th>
<th>Laboratory Level</th>
<th>Pre-Test</th>
<th>Lab 1</th>
<th>Lab 2</th>
<th>Post-Test</th>
<th>Percentage Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1</td>
<td>75</td>
<td>72</td>
<td>74</td>
<td>78</td>
<td>3.85</td>
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<tr>
<td>F</td>
<td>1</td>
<td>1</td>
<td>76</td>
<td>73</td>
<td>78</td>
<td>78</td>
<td>2.56</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>2</td>
<td>84</td>
<td>87</td>
<td>86</td>
<td>88</td>
<td>4.55</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>3</td>
<td>85</td>
<td>85</td>
<td>90</td>
<td>89</td>
<td>4.49</td>
</tr>
<tr>
<td>E</td>
<td>3</td>
<td>4</td>
<td>69</td>
<td>85</td>
<td>90</td>
<td>78</td>
<td>11.54</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>5</td>
<td>72</td>
<td>88</td>
<td>92</td>
<td>80</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 1. The varying levels of instructional technology and laboratory technology for each class. Also the raw data collected from four assessments and the percentage increase from the pre-test to the post-test.
Figure 1. Pre-test and post-test scores of six different classrooms are compared when different levels of technology were used to present the information to the classes.
Figure 2 Percentage Increase with Various Technological Use

Figure 2. Percentage increase from the pre-test to the post-test of six different classes are compared when different levels of technology were used to present the information.
Figure 3 Lab Scores with Various Technological Use

Figure 3. Two labs are compared for six different classes when different levels of technology were used by the students to collect and analyze data.
Discussion and Conclusion

As a result of this experiment, it has been shown that instructional technology does play a role on student achievement in a unit. The students who were taking notes using PowerPoint presentations showed a significant increase from the pre-test to the post-test. The students enjoyed the presentations better than just a lecture or a transparency. The information presented can be enhanced through the use of colors, fonts, and graphics. In addition, a few movie clips were entered into the presentation that showed how indicators worked, and the students commented on their enjoyment of the presentation. The students said that they enjoyed taking notes through the PowerPoint presentation. This is something that each teacher should incorporate as much as possible. If students are engaged during the note-taking phase of their learning, then they will have a better knowledge foundation when entering the lab setting.

During the lab experiments, students used a variety of technology levels, both in data acquisition as well as data analysis. Some students struggled with the initial technology introduction and how each piece of equipment worked. After a few tests and some sample data collection they were able to use it much smoother and quicker. By the time it came for them to collect their actual data and then they seemed much more comfortable and eager to use the new technology they had been introduced to.

Overall the increased level of technology that was used by the students did have an impact on their performance throughout the unit. The largest impact was from the instructional technology which led to a 10% difference from the pre-test to the post-test. The technology that students used throughout the lab experiments led to improved scores, however there wasn't a significant difference between the calculators or the computers,
however there was a difference between using technology vs. not using technology. All of this information should be used to encourage teachers to use technology and prepare the students as best as possible.

Further improvements on this experiment would be using a larger sample size and a few different districts in a variety of economic and academic areas. The sample size that I worked with was around 130 students contained within one district located in a very affluent suburb of Columbus, Ohio, and I would encourage further investigations to explore additional subjects. Additionally, alternative topics can be studied to investigate the effects of different technology used in a laboratory setting.

This experiment supported the fact that students respond well to PowerPoint presentations (Cox & Rogers, 2005) & (Miltenoff & Rodgers, 2003). Students did, in fact, have a complete set of notes and were able to perform better on the assessments based on the lecture information as well as the technology that was incorporated into the laboratory analysis. In addition the students frequently commented on how much better they enjoyed the PowerPoint presentations to the traditional methods which supported Miltenoff and Rodgers', 2003, claim.

As far as teacher preparation, Olentangy Liberty High School, Powell, Ohio, has many training sessions throughout the year. In January of 2006 there was a training session held right at the school to train teachers in the Smart Board so that a new piece of technology would be incorporated into the classroom. There are also many training sessions held throughout the district in a variety of new techniques that teachers could incorporate into the classroom. Kagima & Hausafus, 2001, supported schools that were able to incorporate technology into the professional development programs, and that is
just what Olentangy Liberty High School has been able to do. It has led to many teachers incorporating the Smart Board and designing programs and games to share with each other so that the students benefit from the technology in multiple subject areas throughout the day.
References


Appendix A: Acid and Base Pre-Test

Introduction to Acids and Bases

1. Indicate whether each mixture below is homogeneous or heterogeneous.
   a. fruit cocktail
   b. pickle relish
   c. air
   d. steel
   e. gasoline

2. Indicate the appropriate phase (solid, liquid, or gas) for each of the following:
   a. bronze
   b. air
   c. steel
   d. salt water
   e. table salt

3. Name three chemical reactions that take place around you every day.

4. Table salt, NaCl, is dissolved in a jar of water. When the water evaporates, the salt is left behind in the jar. The dissolving process is most likely ____________.
   a. a chemical change
   b. a physical change
   c. both a chemical and a physical change
   d. none of the above

5. Balance the following equations:
   a. Fe(OH)₃ → Fe₂O₃ + H₂O
   b. NaCl + H₂SO₄ → Na₂SO₄ + HCl
   c. H₂SO₄ + KOH → K₂SO₄ + H₂O
   d. Al + CuSO₄ → Al₂(SO₄)₃ + Cu
Appendix B: Acid and Base Lab

**Acid and Base Lab**

**Safety Precautions:**
Wear safety goggles, and a lab apron. Never put anything in your mouth.

**Equipment:**
- Various solutions
- Droppers
- Tweezers
- Paper Towel
- pH paper

**Introduction:**
One way to measure pH is to use pH paper. This is paper that has been chemically treated with an indicator. This indicator changes color depending upon the pH of the solution. We will be testing various household solutions and determining the pH.

**Procedure:**
1. Using a pair of tweezers, rip a small piece of pH paper A off of the spool.
2. Place a small drop of the 1st solution onto the paper.
3. Compare the color of the paper to the key on the side of the spool.
4. Using a pair of tweezers, rip a small piece of pH paper B off of the spool.
5. Place a small drop of the 1st solution onto the paper.
6. Compare the color of the paper to the key on the side of the spool.
7. Record the pH of the solution (or range of the pH) in the appropriate place in the data sheet.
8. Repeat with each solution- 10 total.

**Analysis:**
1. Describe the pH scale. What value is neutral? What values are bases? What values are acids?

2. Which substances are acids? Which are bases? How did you determine this?

3. Which substance was the most acidic? How did you determine this?

4. Which substance was the most basic? How did you determine this?
<table>
<thead>
<tr>
<th></th>
<th>Color of pH paper</th>
<th>pH value</th>
<th>Actual value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cola</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borax</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vinegar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bleach</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coffee</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antacid Solution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lemon Juice</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analysis Part II:**

1. How well did you do predicting the pH values? Explain what might have happened in your inaccurate values.
Appendix C: Acid and Base Indicator Lab

Acid and Base Indicator Lab

Safety Precautions:
Wear safety goggles, and a lab apron. Never put anything in your mouth.

Equipment:
- Ceramic Spot Plate
- Various solutions
- Indicator Solutions

Introduction:
Another way to measure pH is to use an indicator. Indicators change color depending upon the pH of a solution. We will be using the data we compiled yesterday to explore the properties of three indicators.

Procedure:
1. In each circle on the back of the page, write the correct pHs of the each of the solutions.
2. Using the schematic listed on the back of the page, place three drops of solution into the proper well. Do this for all 12 solutions. (Each solution goes into a separate well!!)
3. Now it is time to use the indicator. Find the bottle labeled with one of the following names: methyl red cabbage juice bromothymol blue
4. Label your data sheet on the back of the page with the indicator at your table.
5. Place 2 drops of the indicator into each well (12 wells total)
6. For each solution, color what it looks like.

Analysis: INDICATOR NAME: ________________________

7. Discuss among your group what you believe scale of the indicator is. That is, what color is it when it is an acid?

8. What pH values does this color occur at?

9. What color is it when it is a base?

10. What pH values does this occur at?

11. Fill in the indicator's colors on the pH scale below. For when the color is in-between, leave a blank space.
12. Now the teacher will place you into alternative learning groups. Share your answers with your new partners. Draw all of the correct scales below.

INDICATOR:

[Diagram of a scale with sections to be filled in]

INDICATOR:

[Diagram of another scale with sections to be filled in]
Appendix D: Acid and Base Post-Test

Acids and Bases

1. On the pH scale below:
   a. Label where acids, bases and neutral are located.
   b. Label the pH range for each of these.

2. Give an example of a solution that is an acid. ________________

3. Give an example of a solution that is a base. ________________

4. Complete the following sentences:
   a. The presence of _______ ions are what give acids their characteristics.
   b. The presence of _______ ions are what give bases their characteristics.

5. Explain what an indicator does.

6. Rank the following solutions from weakest (#1) to strongest (#3)
   a. _______ vinegar, pH = 2.8
   b. _______ soft drink, pH = 3.4
   c. _______ stomach juices, pH = 3.0

7. You have two solutions, Solution A with a pH of 4.0 and Solution B with a pH of 6.0.
   a. Which solution is stronger? ________________
   b. How much stronger is it? ________________

8. You have a solution with a pH of 6.0 and the solution needs to have a pH of 5.5.
   Should you add more acid or more base to achieve the desired pH? WHY is this true?