

Running Head: HIGH-TECH CHALK & TALK

PowerPoint: Encouraging High-Tech Chalk & Talk or Reforms-Based Science Instruction?

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Abstract

This descriptive study explored seventeen secondary preservice science teachers' use of presentation software (i.e., PowerPoint) to support science teaching and learning. Researchers questioned (a) whether teachers prepared to teach with technology would use presentation software to support reforms-based science instruction when and (b) what form this instruction would take. Data included formal and informal interviews, classroom observations, lesson plans, and presentation software files. The researchers used analytic induction to analyze the data. Results indicate that the secondary preservice science teachers used presentation software to support reforms-based science instruction and describe effective ways to use presentation software.

PowerPoint: Encouraging High-Tech Chalk & Talk or Reforms-Based Science Instruction?

The use of presentation software, such as PowerPoint, in the classroom is embraced by faculty and administrators at institutions nationwide. PowerPoint belongs to a class of computer programs known as presentation software. PowerPoint and other similar programs allow the user to create slides, handouts, and notes which may include a variety of audio/visual media. As such, PowerPoint has the potential to facilitate reforms-based science instruction. However, there is very little research examining uses of PowerPoint to support science teaching and learning. Existing research on the effectiveness of PowerPoint has focused on non-science college classes and furthermore, does not provide a clear picture of its potential to support effective instruction.

Research to date on the use of PowerPoint in education has yielded mixed results. A study by Apperson, Laws, and Scepanky (2006) showed that college students enrolled in classes in which the professors used PowerPoint with lectures reported more interest in the class, an easier time paying attention, and greater learning when compared to the same classes in which the same professors used only chalkboards. Several other studies have reported positive outcomes linked to the use of PowerPoint. Investigations revealed that students may find presentation graphics to be more interesting than traditional lectures (Mantei, 2000; Szabo & Hastings, 2000) and that students may have more positive attitudes and greater self efficacy when taught with PowerPoint (Susskind, 2006). PowerPoint also has the possibility to guide students through inquiry when it is used creatively, and has the potential to give teachers more power to point to a wider variety of engaging multimedia to facilitate effective teaching (Adams, 2006).

Other studies (Bartlett & Strough, 2003; Brewster, 1996; Rankin & Hoaas, 2003) have reported that PowerPoint does not make a significant difference one way or another.

Additionally, there has been a considerable amount of criticism about the ways in which PowerPoint is used in classrooms. Tufte (2003) warns that PowerPoint can be used to encourage shallow teaching and learning rather than encouraging a rich interaction between teacher, students, and content. Doering, Hughes, and Huffman (2003) argue that the use of PowerPoint encourages passive, rather than active, learning, stating that students need to learn *with* technology, rather than *from* technology. Even some students have reported that PowerPoint is overused and ineffective (Brown, 2007).

Without preparation to teach science with computer technology, teachers often revert to teaching pedagogies that they were exposed to as students (Sparks & Hirsch, 2000). These pedagogies often include the use of presentation software for passive, rather than active learning. Previous investigations have demonstrated that the teacher preparation program at the authors' institution has facilitated preservice science teachers' use of technology for instructional purposes (Bell, Binns, & Smetana, 2007; Irving, 2003; McNall, 2004; Schnittka, Bell, & Farquhar, 2007). These studies did not, however, look specifically at whether presentation software was used to promote reforms-based instruction.

Science education reform documents specify that science instruction should actively engage students in developing conceptual understandings of key science concepts (AAAS, 1993; NRC, 1996). These reform documents describe the need for a shift away from traditional instructional approaches and toward approaches based on constructivist learning theory. Windschitl (1999) wrote that "constructivism is based on the assertion that learners actively create, interpret, and reorganize knowledge in individual ways" (p. 752). Constructivist teaching should promote experiences that require students to become active, scholarly participators in the learning process (Elliott & Gordon, 2006). Reforms-based instruction is

based on flexible curricula, provides opportunities for students to construct understanding through active learning, and focuses on student understanding of inquiry processes in addition to scientific knowledge. Current reforms in science education can be applied to all teaching strategies, even those that utilize educational computer technology.

Flick & Bell (2000) developed guidelines to assist educators in designing instruction that integrates educational technology applications in ways that support reforms-based instruction. They state that sound instructional approaches and pedagogy should not be ignored just because innovative technological applications become available. In addition, technology integration should support scientific literacy as it is defined by the *National Science Education Standards (NSES)* (NRC, 1996) and *Benchmarks for Science Literacy* (AAAS, 1993), facilitating conceptual development, process skills, and scientific habits of mind. Technology should be used in ways that bring experiences into the classroom which would not otherwise be possible. For teachers, this translates into using technology to help students explore content on a deeper and more interactive level. Finally, the technology should make complex or abstract ideas more accessible to students through visualization, modeling, and multiple representations. This is a powerful use of technology in science classrooms because often scientific models and complex scientific ideas are difficult for students to understand.

The purpose of the present study was to explore preservice science teachers' use of presentation software, such as PowerPoint, to support science teaching and learning.

Specifically, the study addressed the following questions:

1. Do preservice secondary science teachers who are prepared to teach with technology use presentation software to support reforms-based science instruction during their student teaching placement?

2. If so, in what ways do they use presentation software to facilitate reforms-based instruction?

Methods

Participants and Sites

Seventeen preservice science teachers (8 females and 9 males) enrolled in a Masters of Teaching (MT) program at a large public Mid-Atlantic university participated in the study. Participants ranged in age from 23 to 50 during their student teaching semester. The sampling criteria included voluntary participation from the preservice teacher and mentor teacher, as well as permission from the principals of the schools in which data were collected. At the beginning of the study all 17 preservice teachers were seeking certification at the secondary-level in four disciplines: 10 in biology, 3 in chemistry, 2 in physics, and 2 in earth science (Table 1).

Table 1

Background information for the participants.

Preservice teacher	Placement school	Area of Licensure
Amanda	Patterson High School	Biology
Bradley	Jefferson High School	Earth Science
Catherine	Jefferson High School	Biology
Derek	Carmel High School	Chemistry
Gillian	Patterson High School	Biology
James	Patterson High School	Biology
Jennifer	Mahopac High School	Biology
Joey	Jefferson High School	Biology
Josh	Jefferson High School	Chemistry
Kelly	Mountain View Middle School	Biology
Kimberly	Patterson High School	Physics
Lewis	Patterson High School	Earth Science
Libbie	Farmville High School	Biology
Michael	Patterson High School	Chemistry
Mitchell	Patterson High School	Physics
Thomas	Carmel High School	Biology
Vicki	Mountain View High School	Biology

The 17 participants completed their student teaching placements in eight different public schools found in four neighboring school systems in a Mid-Atlantic state. Table 2 presents the demographics of each school represented in the study during the 2006-2007 academic year.

Table 2
Site descriptions for the participating schools.

School	Location	Student population	% Minority students	% Free and reduced lunch
Carmel High School	Urban	1300	45%	32%
Farmville High School	Rural	463	56%	48%
Jefferson High School	Suburban	1100	23%	20%
Mahopac High School	Rural	788	13%	18%
Mountain View Middle School	Suburban	800	7%	8%
Mountain View High School	Suburban	1000	7%	8%
Patterson High School	Suburban	1600	16%	12%

The schools involved in the study were found in rural, suburban, and urban settings. School population ranged from 463 to 1600 with an average of approximately 1000 students. The percentage of minority students varied considerably based on location, with one of the rural schools and suburban schools showing less diversity than the urban school or the second rural school. The percentage of students receiving free and reduced lunch ranged from 8% in suburban areas to 48% in one of the rural high schools.

Teacher Preparation Program

In the teacher preparation program that served as the context for this study, preservice science teachers enrolled in multiple courses that emphasized how to incorporate educational technology. Instruction in these courses was structured around the Flick and Bell (2000) guidelines that focus on the meaningful use of technology. In each course, preservice teachers learned to use educational technology to support effective instructional practices and help

students learn important science content. One course was an educational technology course that placed an emphasis on science content. Students learned effective, standards-based ways of integrating technology into science classrooms. How to appropriately use presentation software was emphasized in a two-semester science methods course and one-semester student teaching seminar. The instructors for these courses modeled appropriate uses of presentation software. The instructors also showed how *not* to use presentation software, i.e. including too many words on a slide, pictures that are blurry or too small, or slides that are too flashy. The participants were then required to design instructional lessons that incorporated presentation software to show that they understood how to appropriately use it as a teaching tool.

One lesson in their student teaching seminar specifically focused on the advantages and disadvantages of presentation software such as PowerPoint. As part of the lesson, participants developed a list of possible advantages and disadvantages of PowerPoint (Table 3).

Table 3
Possible advantages and disadvantages of PowerPoint according to the participants.

Possible Advantages	Possible Disadvantages
- Images give visual stimulation	- Low student engagement
- Easy to incorporate other technologies: <ul style="list-style-type: none"> o Video clips o Simulations o Animations 	- Too much text
- “Home” slide → Students choose what you will do next	- Takes away from student thinking
- Flexibility – allows for teachable moments	- Spoon-feeding notes
- Questions, Think-Pair-Share	- Too linear
- Benefits variety of learners	- Distractions from content (sounds, transitions, etc.)
- Organize information	- Reading from slides
- Time efficient	- Presentation overly focused (doesn’t allow for teachable moments – some people feel they can’t deviate from slides)
- Record of notes available for students	

The participants agreed that one advantage of PowerPoint is that it allows for an increase in student engagement. They agreed that incorporating images, simulations, and video clips into

a PowerPoint document increased the level of student engagement in a typical lesson.

Participants also agreed that one disadvantage of PowerPoint is that it can lead to a decrease in student engagement if used inappropriately. Table 3 lists specific examples of what participants considered to be ineffective uses of PowerPoint.

Data Collection

A variety of data sources were used to characterize the participants' instructional practices with presentation software. Collected data included formal and informal interviews, observations, lesson plans, PowerPoint and SMART Notebook files, and teacher reflections. SMART Notebook software developed by SMART Technologies is a free download from smarttech.com. It allows users to create presentations similar to PowerPoint, but with additional features specific to interactive whiteboards. This wide variety of data allowed the researchers to fully characterize each participant's instructional uses of presentation software, increasing the internal validity of the results through triangulation.

The participants were formally interviewed prior to and after their student teaching as well as informally throughout the semester. The interview questions probed the preservice teachers' goals for the use or non-use of presentation software for a particular lesson, and their perceived successes and frustrations with the presentation software. Each participant was observed for an entire lesson at least five times over the course of the semester of their student teaching. Researchers took field notes to describe their particular use or non-use of technology, making note of how they used presentation software, if at all. The researchers also collected all lesson plans with a presentation software component as well as all presentation software files. This made it possible to support participants' statements during their interviews on lessons that

the researchers were unable to observe. Finally, each preservice teacher wrote a reflective essay evaluating three lessons they taught with technology.

Data Analysis

All three researchers participated in the data analysis, which followed an analytic induction process as described by Bogdan & Biklen (1992). The researchers reviewed all data sources with the goal of characterizing how presentation software was used in each lesson. From this review, the researchers developed a pedagogical profile for each participant that included the participants' reported experiences from their interviews and corroborating evidence from lesson plans and other artifacts. Once these profiles had been developed, each researcher returned to the data in an iterative fashion to search for disconfirming evidence. Prior to analyzing the entire data set, the researchers' interpretations of a common data set were analyzed, compared, and re-analyzed in order to establish inter-rater agreement.

Results

The findings of this study revealed that participants used PowerPoint to facilitate reforms-based instructional practices such as:

1. Visualization of abstract concepts
2. Increased student engagement
3. Inquiry-based teaching and learning

Additionally, the data revealed that the participants found PowerPoint helpful with their planning and instructional delivery. Quotes from their exit interviews support this finding.

Visualization of abstract concepts

All participants included digital images, animations, and simulations to help students better understand abstract concepts. Participants reported that they searched for and acquired these digital resources while planning lessons. Visual images were used to help the participants make analogies and ground the abstract in the concrete. Much of what science has to offer contains abstract concepts that many students have trouble getting their heads around. The following examples illustrate how the participants used presentation software to facilitate making abstract concepts more concrete for their students.

One of the more difficult topics to make concrete in biology classrooms is genetics. Students typically learn about genetics by solving problems on Punnett squares or using images and diagrams from textbooks. The participants in this study used PowerPoint to make genetics more concrete. They incorporated a variety of images, simulations, and animations to help students learn genetics. For example, in a lesson on karyotypes, Jennifer included many karyotype images and photos of children with chromosomal abnormalities to help students visualize human chromosomes, as illustrated in the following vignette.

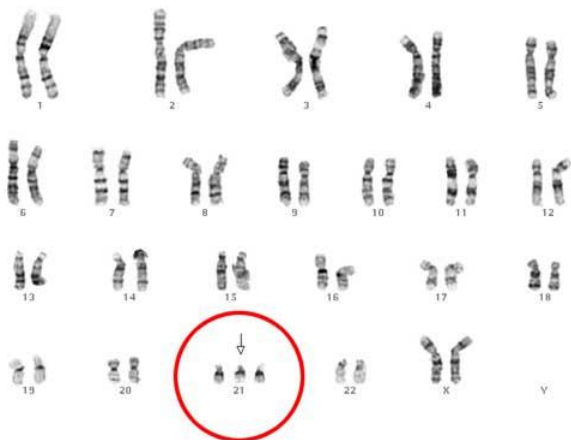
Vignette 1: Karyotypes.

Jennifer began teaching her students about the human karyotype, the microscopic image of the 23 pairs of chromosomes in a somatic cell. She said, "Today we are talking about genetic mutation and karyotyping. I personally think that this is where biology gets interesting!" She asked several students what they knew about karyotypes and opened up a PowerPoint presentation that had several different karyotype images as well as images of different genetic disorders (see Figure 1). Jennifer asked, "Can you see any chromosomal abnormalities in the karyotypes?" Some karyotype images revealed an additional chromosome, or a missing piece of a chromosome. She described the effects of

chromosomal abnormalities on humans, and projected some photographs of children affected with the disorders. About Klinefelter’s Syndrome, one girl asked with hesitation, “Are they guys or girls?” to which Jennifer replied, “They are males, but they have feminine features.” The girl asked, “How rare is the disorder?” and Jennifer replied that it occurs in one in 500,000 males, and commented how difficult it would be to have the syndrome. When they moved on to discuss Turner’s syndrome, another girl asked, “Do they have a difficult time breathing?” to which Jennifer answered deftly, “I didn’t read about that but I can look it up for you.”

The abstract concept that human cells contain chromosomes which contain genes was made concrete through these images and photos. When asked about this lesson in the exit interview, Jennifer stated that “showing images of genetic disorders and karyotypes helped students understand the impact of genetic mutation and really enhanced the lesson.”

A.



C.

B.



D.

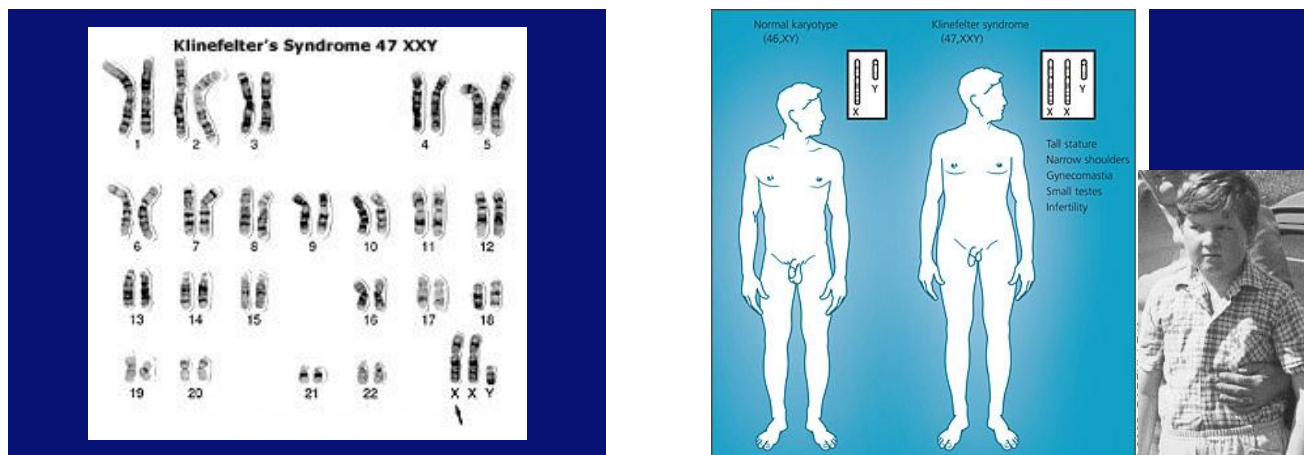


Figure 1. Four slides from Jennifer's PowerPoint on Karyotypes. A and B show Down Syndrome and C and D show Klinefelter Syndrome.

Derek used PowerPoint in many lessons. He included images in his PowerPoint presentations as one way to make abstract chemistry concepts more concrete for his students. In a lesson on periodic trends, Derek used the analogy of a snowman to teach atomic radius. Derek showed a slide of a snowman upright and on its side to illustrate the atomic radius trend (Figure 2). He told the students that as you go down the periodic table, the atomic radius gets bigger which is like a snowman standing up and as you go across the periodic table, the atomic radius gets smaller like a snowman on its side. Derek later told the researchers that this analogy was one of his favorite analogies because the students always remembered the picture of the snowman.

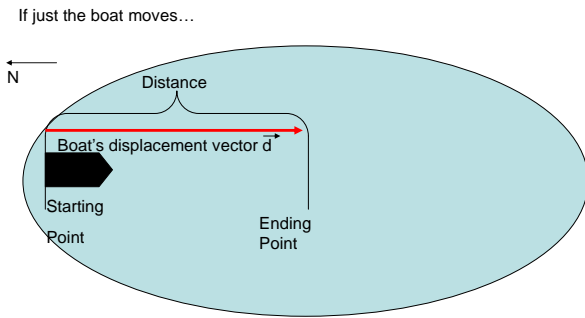
Atomic Radius = Snowman



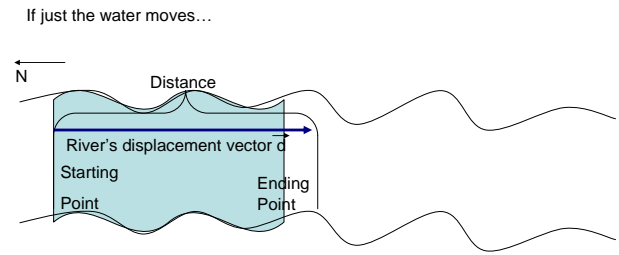
Figure 2. Derek used the analogy of a snowman to teach atomic radius.

Kimberly was another preservice teacher who used PowerPoint in innovative ways to make abstract concepts more concrete. After a lab on displacement vectors, Kimberly noticed that several students did not have a clear understanding of the concepts. Instead of having a simple discussion with the class, Kimberly designed a PowerPoint presentation to help her explain this abstract concept (Figure 3). Kimberly animated the slides so the “boat” and the “water” could move. In the first slide (Figure 3A), Kimberly showed students the displacement vector for when just the boat moves. In the second slide (Figure 3B), Kimberly showed students the displacement vector for when just the water moves. In the third slide (Figure 3C), Kimberly showed students the different displacement vectors for the movement of the boat and the water. Finally, in the last slide (Figure 3D), Kimberly showed students how to find the resultant vector for the boat and water together. Kimberly later told the researchers that this PowerPoint presentation on displacement vectors really helped her students grasp the concepts.

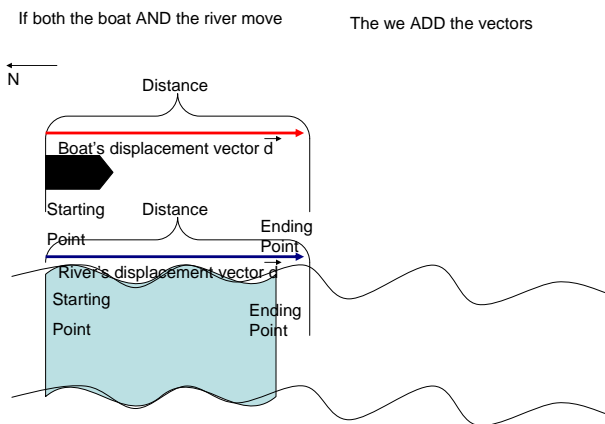
A.



B.



C.



D.

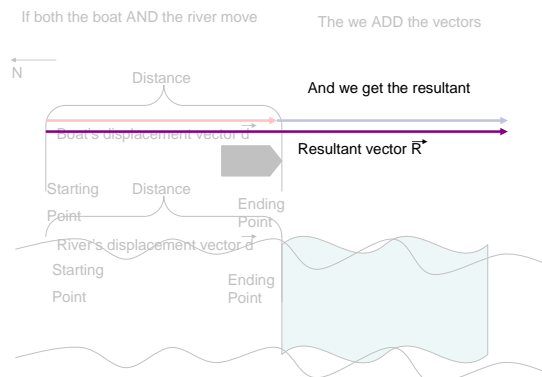


Figure 3. Kimberly's PowerPoint presentation on displacement vectors.

Increased student Engagement

Students are engaged in their own learning when they are attentive and participating, and also invested and interested in the process of learning. Participants used presentation software to gain the attention of students, and help them make a commitment to their own learning. Engaged students are excited about learning, they stay on task, they ask questions, they tune out distractions, and they actively participate in the discussion or activity presented to them. The

following examples illustrate how participants use presentation software to increase student engagement.

Many used PowerPoint as a basic structure for the presentation of individual lessons. Additionally, participants included links to online simulations, websites, videos, and sound files, providing a more engaging method of teaching the content through PowerPoint. Libbie's lesson about populations began with engaging images of animal and human populations and thought-provoking questions. The following vignette illustrates how the use of PowerPoint helped Libbie engage her students.

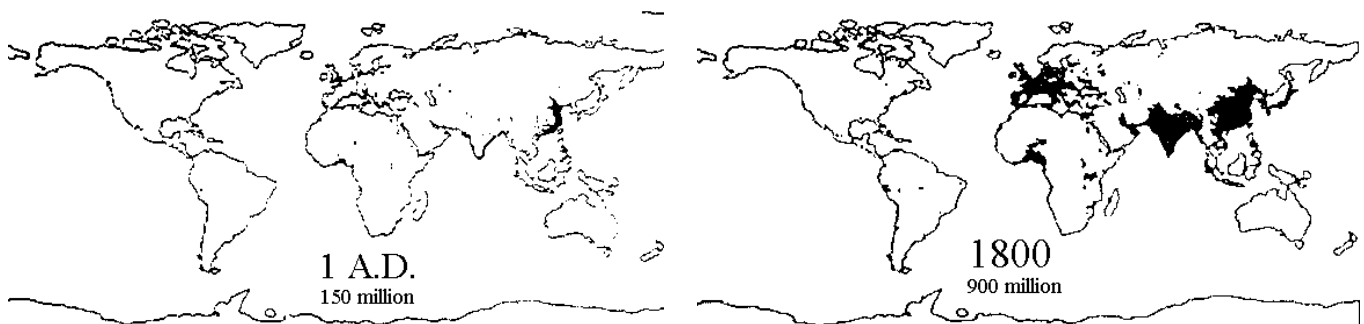
Vignette 2: World's Population

Libbie's afternoon class is known to be particularly ill behaved. Students frequently sneak onto the Internet with their school-issued laptops and play on-line games during class. On this day, Libbie has prepared a PowerPoint presentation about population growth. She begins with some images of animals, and students start to shut down their laptops and exit out of their computer games. Libbie stands in the back of the room so she can see whether students are goofing off on their laptops, and she forwards the PowerPoint to a slide that shows the world's population changing exponentially with a series of shaded-in world map images¹. The images are striking and shocking, as the shading in some areas is growing faster and darker, while other areas remain unshaded (see Figure 4). Several students start taking notes in Word on their laptops. One boy gets up out of his seat and runs to the projected image and asks, "Where is this?" pointing at India, and "Where is this?" pointing at Canada. The chatter in the classroom changes as students start discussing the issue of population growth amongst themselves. A student comments, "It's like in a fish pond. If you get too many brim, they change colors." Libbie

¹ <http://desip.igc.org/mapanim.html>

shows a population graph and asks students for an interpretation and predictions about the future of the world. They don't respond until she clicks on a link on the slide and shows a website with a rapidly changing population clock. A boy gets up out of his seat to see the clock closer. The students are amazed that our population keeps going up constantly and rapidly. They are mesmerized by this novel discussion, and manage to behave themselves somewhat appropriately for these few minutes. When Libbie concludes the PowerPoint show and has students get out paper and crayons to draw a comic strip representing population growth, their behavior reverts back to the usual- boys start playing games on computers, getting up and rough-housing with each other, banging on desks with rulers, making fun of one another's regional accents. Libbie commands their attention once more when she projects the population clock again. "We're still growing!" she says with a smile.

Although Libbie typically had a difficult time engaging her students, this PowerPoint presentation served as a useful way to hook her students and keep them on task. Her use of PowerPoint and online animations proved to be successful when it comes to engaging her students.



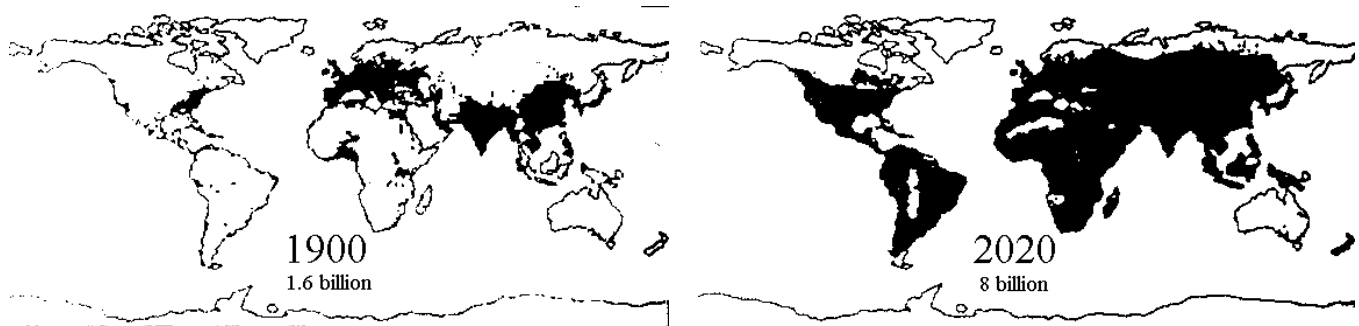


Figure 4. Some images from the animated map Libbie used to teach about population.

In a lesson on the model of the atom, Derek included several images of various scientists and the equipment they used to make their discoveries. He discussed Democritus, Dalton, Thomson, Rutherford, Millikan, and Bohr. For each scientist, Derek used video clips as a way to further explain their contributions. His discussion on Rutherford was especially engaging, as the following vignette illustrates.

Vignette 3: Rutherford's gold-foil experiment.

Derek advances to the next slide which says Rutherford and Gold Foil. He clicks a link at the bottom of the slide that goes to the website, science-o-nator (see Figure 5). "Underneath this question mark is a shape. What can we do to determine this shape?" said Derek. He moves the shooter around the screen and shoots a pellet. "They just go through," said a student. "Not all the time. Where should I point this to find out?" asked Derek. "Go to the top," said a student from the back. Derek moved to the top of the image and shot some pellets. "It goes through," said Derek. Several students begin to move around and shout where Derek should put the shooter. He tries shooting the pellets from several different locations. One student gets out of his seat to point out the hidden shape. As students continue to shout out what shape they think is underneath the question mark, Derek said, "Let's get some evidence before making things up." One student suggests several different angles. Another student says, "It's the last shape, it's the

square.” Derek clicks on the question mark and reveals that the shape is a square. The class then repeats the activity with different shapes. “Good job everybody,” said Derek.

“This simulates how Rutherford figured out what is inside of an atom.” He clicks back to the PowerPoint and discusses Rutherford’s discoveries.

This vignette shows how Derek was able to engage his students in what can be considered a boring topic by many students. His use of video clips and simulations, each linked to his PowerPoint presentation, proved to be a successful way to teach his students about the different scientists who contributed to the understanding of the atom.

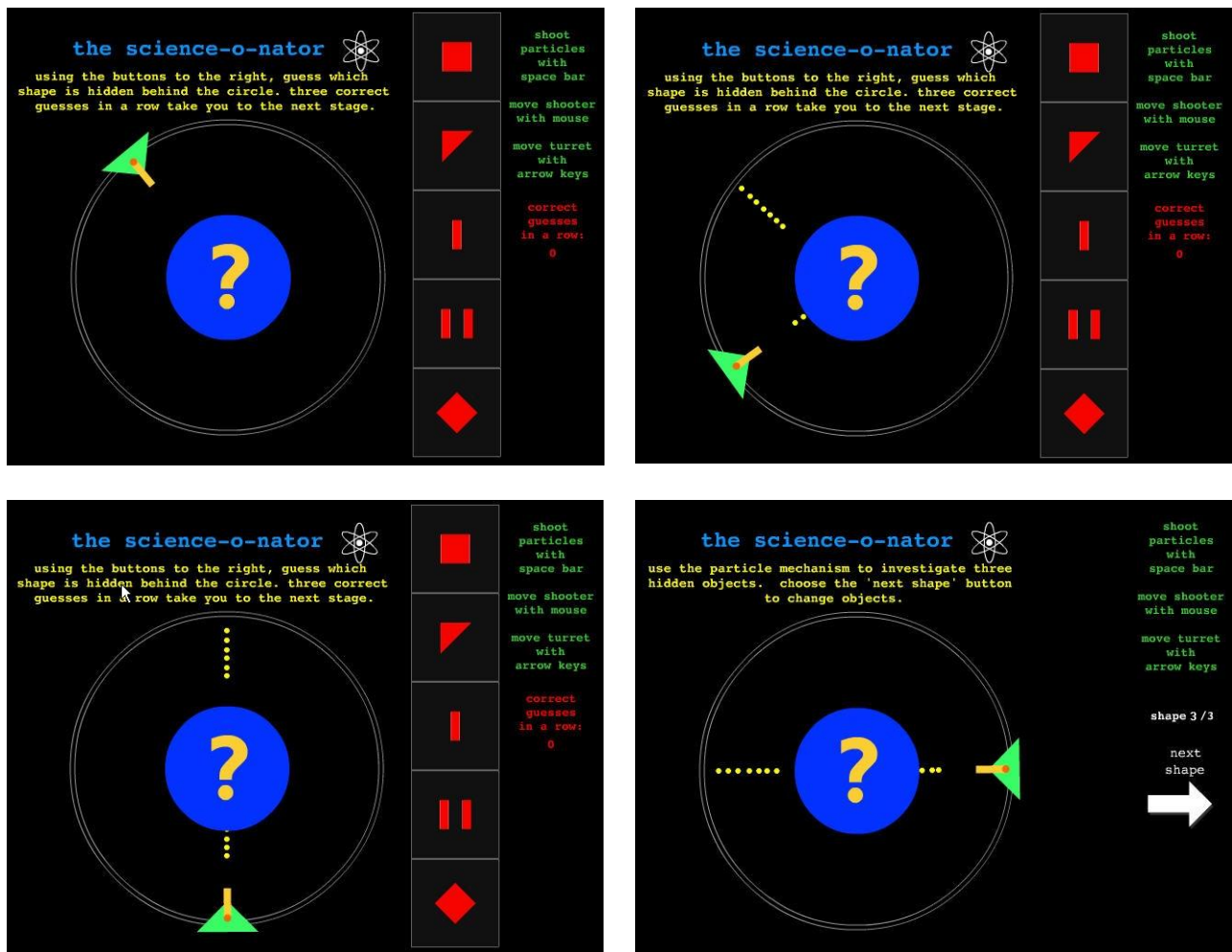


Figure 5. Screenshots from the simulation Derek used in his lesson, the science-o-nator.

For a review on atomic structure, Josh created a SMART Notebook lesson to review the atomic structure of isotopes and ions. Students manipulated the number of electrons, protons, or neutrons in an atom at the board. They counted the number of each particle, wrote the appropriate chemical symbol, and checked their work by moving the “check my answer” box.

Figure 6 shows four slides created with the Smart Notebook software used in the lesson on atomic structure.

A.

PROTONS	NEUTRONS	ELECTRONS
1	1	1

CHECK MY ANSWER

B.

PROTONS	NEUTRONS	ELECTRONS
1	1	2

CHECK MY ANSWER

C.

PROTONS	NEUTRONS	ELECTRONS
30	35	28

CHECK MY ANSWER

PROTONS	NEUTRONS	ELECTRONS
82	125	82

CHECK MY ANSWER

PROTONS	NEUTRONS	ELECTRONS
55	78	54

CHECK MY ANSWER

PROTONS	NEUTRONS	ELECTRONS
52	76	54

CHECK MY ANSWER

D.

PROTONS	NEUTRONS	ELECTRONS

CHECK MY ANSWER

^{40}Ar

PROTONS	NEUTRONS	ELECTRONS

CHECK MY ANSWER

$^{137}\text{Ba}^{+2}$

PROTONS	NEUTRONS	ELECTRONS

CHECK MY ANSWER

$^{80}\text{Br}^{-}$

PROTONS	NEUTRONS	ELECTRONS

CHECK MY ANSWER

Figure 6. Josh's SMART Notebook slides for students to manipulate the atomic structure.

This simple SMART Notebook presentation proved to be a great way to engage students in the lesson. Not only did it engage students, it helped them to visualize an abstract concept that many students struggle to understand. In his exit interview, Josh stated

Students really enjoyed this activity. They were on their toes the entire time because they knew that I would call on them at random. The students just didn't want to be embarrassed if they had to come to the board. So activities like this were really helpful with engagement. (Josh, Exit Interview)

Gillian linked an online pH simulation to her PowerPoint presentation to help her class conduct a simple inquiry activity in which they determined the pH of unknown samples. The following vignette illustrates the level of student engagement in this lesson.

Vignette 4: Testing the pH.

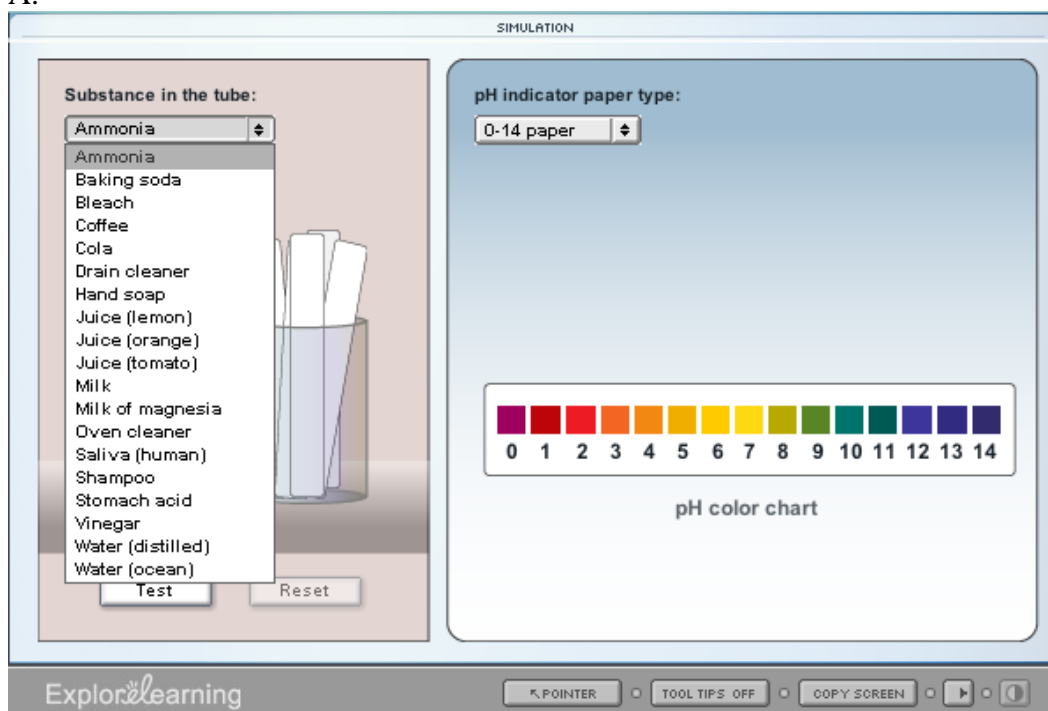
Gillian advanced to the next slide that said pH and discussed the pH scale with the class. The next slide said pH Analysis Gizmo and had a screen shot of a simulation (see Figure 7). She clicked the image and the screen changed to an online simulation called pH Analysis². She said later that she linked the image to the online simulation. Gillian asks for a volunteer. A girl comes up and starts to select a liquid. Students tell her to choose beer. The student selects beer and runs the test, finding that it has a pH of five. Gillian asks, "Is it an acid or base?" "It's an acid," the students said in unison. "Is it a strong or weak acid," asked Gillian. "Weak," said the students. The girl sits down and a boy volunteers to test another liquid. The boy selects stomach acid and says, "Stomach acid has a pH of two." Some students debate that it's closer to one, but settled on two. Gillian asked students why stomach acid needed to be a strong acid, and asked them which medicine they might take if they had acid reflux. This lead to the next student choosing milk of magnesia to test, and he found that it had a pH of 10 or 11. Gillian said, "So it has a pretty basic pH. That's why you take a base to neutralize stomach acid." Gillian calls on a few more students to try the simulation. After they are done, students

² <http://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=432>

ask Gillian to test cola. Gillian selects cola from the list of liquids and runs the test. They find that cola has a very low pH.

Gillian used PowerPoint as a starting point for an engaging lesson on pH scale. Students enjoyed selecting the liquids they were going to test and the entire class got involved in the discussions. The lesson finished with one student asking if there is anything that has a pH lower than zero. Gillian responds, “I don't think so, but with the way things are changing in science, they might have to change the pH scale if they do!”

A.



B.

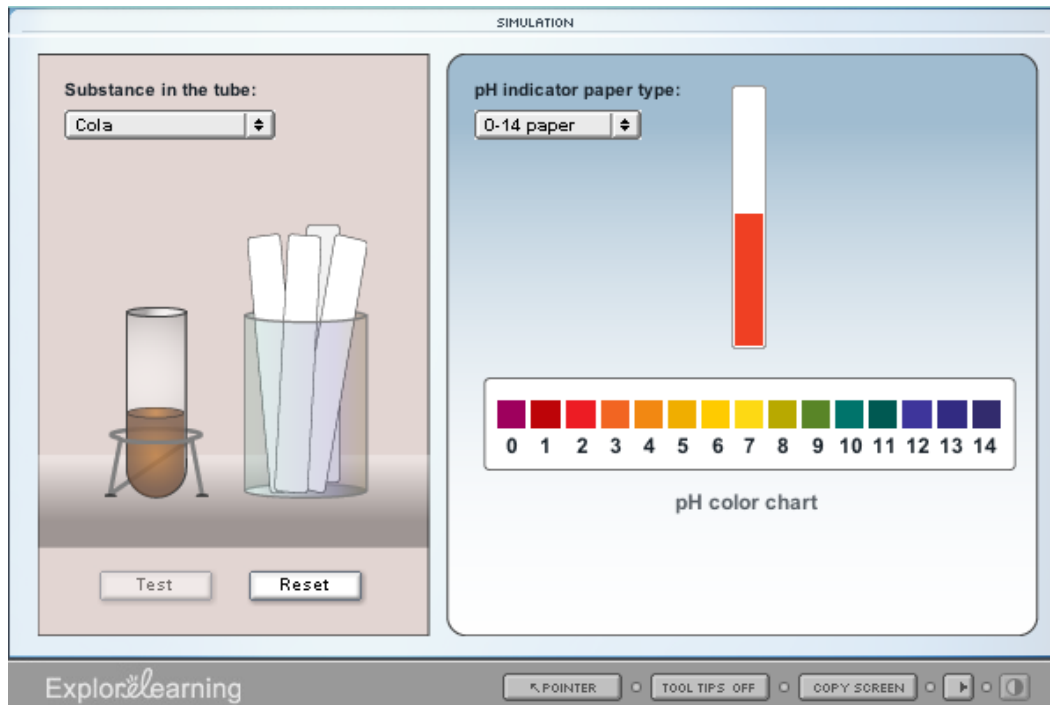


Figure 7. Testing the pH scale of a variety of liquids.

Inquiry-based teaching and learning

The *NSES* (NRC, 1996) define inquiry as a “multifaceted activity that involves using tools to gather, analyze, and interpret data, making observations, posing questions, planning investigations, reviewing what is already known in light of experimental evidence, proposing answers, explanations, and predictions, and communicating the results” (p. 23). All of the participants incorporated inquiry into their student teaching in some way. Many used presentation software as a way to get students involved in an activity. In some cases, presentation software functioned as the primary way for students to do an inquiry activity. The following examples are two ways participants used presentation software to do inquiry activities.

Vicki designed an inquiry lesson on karyotypes using presentation software. In this lesson, she challenged students to answer the question, “What’s the patient’s diagnosis?” The

following vignette from an observation shows how Vicki incorporated presentation software in this inquiry activity.

Vignette 5: Diagnosing patients.

Vicki began the lesson by projecting a microscopic image of the 23 pairs of chromosomes in human somatic cells. This led to a brief class discussion on chromosomes and why humans have 23 pairs. As part of the instruction, Vicki transitioned to the simulation, "Making a Karyotype" to show students how homologous pairs match up. She clicked a button and made the karyotype automatically form while asking, "So, when does a scientist want to take a picture of the chromosomes?" A student responded, "When they are dividing." Vicki used this response to begin a discussion about abnormalities in chromosome formation and how this leads to specific genetic diseases. She showed students the karyotypes for Down Syndrome, Turner Syndrome, and Klinefelter Syndrome and discussed the causes of these genetic diseases.

After this discussion, Vicki projected an online karyotyping activity (see Figure 8). In this activity, students were required to diagnose patients based on the clinical symptoms and digital images of the karyotypes. Vicki turned to the class and asked, "Who wants to be the doctor today?" A student came up to the board, began to read the patient's history, and completed the karyotype from the patient's cell, moving a single chromosome to its homologous chromosome. Vicki asked, "What do you notice about this karyotype?" A student responded, "Down syndrome." "Good" exclaimed Vicki as she moved on to the next patient. Different students volunteered to diagnose the remaining patients at the board while their classmates discussed the diagnosis. Throughout the

activity Vicki continued to call her students doctor and when students had a difficult time diagnosing the patient, Vicki said, “Come on guys, this patient’s life is in your hands!”

Vicki used presentation software as a way to conduct an engaging inquiry activity.

Students enjoyed diagnosing each patient’s disease similar to the way medical doctors diagnose genetic disorders. In the process of making a diagnosis, students used their previous knowledge of chromosomes and karyotypes to debate the interpretation of the available data and reach consensus on the diagnosis. **Figure 8 shows several screenshots from the online karyotyping activity Vicki used in her lesson.**

INSERT FIGURE 9 HERE

Figure 8. Screen shot of the online karyotyping activity Vicki used in her inquiry lesson.

As an introduction to a Nature of Life unit, Kelly used presentation software to do a whole-class inquiry activity. She showed students different images of mysterious objects called “Lithops,” which she claimed to have discovered in her backyard. Kelly challenged students to answer the question, “Are Lithops living things?” Students examined a series of images (see Figure 9), recorded observations and inferences, and concluded if the Lithops were alive.

A.



B.



C.

D.



Figure 9. Example images of “Lithops” used in inquiry lesson.

Kelly’s lesson on “Lithops” was an innovative way to involve students in an inquiry activity using presentation software. Each image introduced new evidence, either adding or conflicting to students’ original hypotheses. Students used skills such as observing, questioning, analyzing, inferring, and predicting to determine if Lithops were alive. They also drew from past experiences and knowledge to come to their conclusions. In her reflection, Kelly wrote,

This lesson sparked an interest in the students. Because I refused to tell them the answer to the question “Are Lithops living things?” many of the students went home and looked them up on the Internet, asked their parents, and looked in the reference book in the library. Because the students were involved in the process of discovering if Lithops were alive, they were very curious to know if they were right or not. (Kelly, Inquiry reflection)

Participants' comments on PowerPoint

The observations, lesson plans, and other teaching artifacts that were collected provided evidence that presentation software helped participants teach effectively and helped students stay engaged in the learning process. In the participants' own words, they reported on how PowerPoint was beneficial in their planning and instructional delivery, and they also addressed how PowerPoint increased student engagement in their opinions.

Through the process of data analysis, coding, and collapsing codes into broad themes, two main categories were generated from an analysis of the interviews done with participants after they completed their student teaching. The main categories we found are:

1. Efficiency
2. Engagement

Efficiency

Efficiency refers to several aspects of instruction. Some participants commented on how PowerPoint helped them improve issues resulting from handwriting notes **on the chalkboard or an overhead transparency**. Others said that being able to reuse their PowerPoint presentations was very helpful. Finally, a few participants commented on how PowerPoint helped them improve on prior mediums of instructional delivery used by their mentor teachers.

In regard to handwriting issues, some participants stated that they liked how PowerPoint made it possible for them to not worry about their poor handwriting or having their backs to the class.

PowerPoint to me is professional looking, my handwriting being a lefty is sloppy, so in that sense I can, I feel more professional having a laptop in front of me projecting whatever it is I want to project. (James, Exit Interview)

I just really liked it (PowerPoint) because it allowed me to put my lessons together, as far as my lecture part of the lesson together beforehand so that, because I remember when I was in high school the teachers would have their back to the class half the time putting notes up on the board and I just feel like, especially with a 45 minute class, it really helps with time not to have to spend so much time writing the notes out so that the kids can copy it. And also I just have really terrible handwriting because I'm left-handed and I just get chalk all over the place. That really helped me, and I also think it helped the students. (Jennifer, Exit Interview)

Many participants talked about the fact that they could reuse their PowerPoint presentations throughout the day.

I am not saying PowerPoint is the end-all and be-all, but, even I got annoyed and frustrated by rewriting the same thing for the 19th hundred time over. Writing stuff and erasing it and having a kid who wants to go back to this or back to that. I like the consistency of PowerPoint. If I'm wide awake because I just had my coffee and first period is getting a dynamo of a lesson. Then there is no reason that fifth or seventh can get the same kind of lesson. It can really give me the opportunity to show exactly what's in my head more effectively. And certainly there were times, early on, making different charts are things on the board, and it just takes a while to sit there and you've got to give them something to do, and I wasn't really doing that. (Mitchell, Exit Interview)

In his exit interview, Michael discussed the benefit of uploading their PowerPoint presentations to the class website:

Researcher: Do you put all your notes up on the class website, all your PowerPoint presentations?

Michael: Pretty much all of them. There's stuff I leave out. Like I'll leave out sample problems or I'll leave out answers to sample problems.

Researcher: Do most kids print those out in advance of the lesson, or is it only afterwards?

Michael: The standard level classes, it's been becoming an assignment to have the notes prior to the class. A lot of the honors students print it out before hand. And then with the advanced some come prepared and some realize that after they look through it they want to look at it again and will print it out afterwards.

A few participants stated that they updated the way their mentor teachers presented information to the students. Some of the mentor teachers were using the chalkboard or overhead transparencies to share information with their students. Participants in these classrooms commented on how they either created their own PowerPoint presentation to replace the chalkboard and overhead transparencies.

I used her (the mentor teacher's) notes as a template and I converted all her notes for the ones that I taught to PowerPoint. When I was leaving, the last few days, she was using her notes still on the overhead. (Gillian, Exit Interview)

Other mentor teachers already used PowerPoint presentations to display their notes. In her exit interview, Jennifer discussed how she modified her mentor teacher's existing PowerPoint presentations to make them more interactive (see Figures 10 and 11).

Jennifer: When I was planning on my own I made my own (PowerPoint presentations). But the last three weeks when we were planning together, I took her PowerPoint presentations and moved words around and put more pictures in and stuff like that.

Researcher: So when she taught she had her version with no pictures, and when you taught the same lesson on the same day, you used your version with the images?

Jennifer: Yeah. Same room, same everything except for my PowerPoint presentations had a lot more slides with pictures on them.

INSERT FIGURES 10 AND 11 HERE

Engagement

All participants emphasized the importance of making their PowerPoint presentations engaging. Each participant discussed how they included more visual components such as digital images, animations, or simulations.

I think the oral stimulation and the visual stimulation together helped them learn the material. They're more likely to pay attention when there's something colorful and

moving rather than me standing up there talking to them, or having a black and white overhead. (Vicki, Exit Interview)

I tried to make the lessons more interesting with images-even just having one image would lead to a story or anecdote and get them interested. For example, I had this lesson on the kingdoms of life and I had these little mini video clips like of the plant that actually closes up if you touch it. Overall the lesson was just really good using PowerPoint, but also having really good images, that really helped. I chose images that were unusual, for instance when I was doing plants I had a picture of a redwood. Kids are interested in those trees that are that tall. And I had little clips, and I think overall that was really successful. (Gillian, Exit Interview)

It took less time for me to put great digital images into a PowerPoint than the overhead, because with the overhead we did not have a color copier. So, the overheads had to be black and white. I wanted to show the students the periodic table that had certain elements colored in, so they could see what were trace elements and then carbon, hydrogen. Even that, putting it into a PowerPoint was so much easier versus putting it onto an overhead where I couldn't use color. (Catherine, Exit Interview)

Some of the participants also discussed how they made the effort to break up their PowerPoint presentations into different components to include more teacher interactions. These participants focused on accompanying their PowerPoint presentations with additional instructional strategies.

PowerPoint presentations aren't infallible. They could be designed interesting, efficiently, and organized not too long, they failed just like any other boring lecture. There are some PowerPoint presentations that could be broken up by some teacher interaction more than they were. (Joey, Exit Interview)

I added in frequent breaks but, more I try to at least have a PowerPoint but I would make sure that it was short. I would throw in things that they could do. So I would have points at which they could talk with a buddy and relate one concept to another. So instead of just making it (PowerPoint) totally teacher centered, it would be teacher centered for like two minutes, and then they would do something. Then like five minutes back on me giving them new information and so on. (James, Exit Interview)

Discussion and Conclusions

The purpose of this study was to explore preservice science teachers' use of presentation software, such as PowerPoint, to support science teaching and learning. Specifically, the study addressed the following questions:

1. Do preservice secondary science teachers who are prepared to teach with technology use presentation software to support reforms-based science instruction during their student teaching placement?
2. If so, in what ways do they use presentation software to facilitate reforms-based instruction?

The following section summarizes the results of the investigations as answers to each research question listed above. A thorough analysis of a wide variety of data sources including interviews, classroom observations, lesson plans, and presentation software files allowed for triangulation and made it possible for the researchers to answer these questions with a high degree of confidence.

Question 1: Do preservice secondary science teachers who are prepared to teach with technology use presentation software to support reforms-based science instruction during their student teaching placement?

Critics of presentation software, like PowerPoint, have said that PowerPoint can encourage shallow teaching rather than rich interaction between the teacher, students, and content (Tufte, 2003). Others argue that the use of PowerPoint encourages passive, rather than active learning (Doering et al., 2003). However, our results seem to indicate that it is not PowerPoint itself that encourages shallow teaching or passive learning, it is the user, or in this situation, the teacher (Brown, 2007; Showm, 2003). Nevertheless, critics continue to blame

PowerPoint for shallow teaching and passive learning as long as teachers remain unprepared to effectively teach science with computer technology (Sparks & Hirsch, 2000).

The results of this study indicate that preservice teachers prepared to use presentation software to support reforms-based science instruction used it consistently and effectively in a variety of innovative and engaging ways, facilitating greater participation, inquiry, and motivation to learn. Participants' preparation included five courses that emphasized appropriate uses of educational technology. Each of these courses followed the educational technology guidelines established by Flick and Bell (2000). The educational technology course showed participants how to operate presentation software, while the remaining courses emphasized appropriate uses of presentation software. Participants also had several opportunities to practice using PowerPoint and receive feedback from their instructors. Due to this preparation, each participant entered student teaching with a master collection of multiple resources to use with their PowerPoint presentations, including digital images, video clips, animations, and simulations.

All of the participants used presentation software, such as PowerPoint or SMART Notebook, to convey information to their students. Very few used PowerPoint in a strictly didactic way. As the results show, the participants used PowerPoint to make abstract concepts more concrete, engage their students, and conduct inquiry activities. They incorporated a variety of digital images, video clips, animations, and simulations in their PowerPoint presentations. These resources either came from the master collection they made during their methods courses or they found the resources themselves.

Participants' responses in their exit interviews provide more evidence to support the level of preparation they received. Each participant emphasized the importance of using visual

stimulation, such as digital images, video clips, animations, and simulations in their PowerPoint presentations just as they were instructed in their coursework prior to student teaching. They also indicated that they fully understood the difference between appropriate and inappropriate PowerPoint presentations. I DON'T LIKE THE WORDING OF THIS PARAGRAPH. I THINK IT IS FINE NOW.

Question 2: If so, in what ways do they (preservice teachers) use presentation software to facilitate reforms-based instruction?

The participants used presentation software in a variety of ways to facilitate reforms-based instruction. This included using presentation software to teach abstract concepts, increase student engagement, and teach inquiry-based lessons. Examples of how participants used presentation software to teach abstract concepts ranged from simple analogies such as comparing a snowman to atomic radii, to advanced concept visualization such as creating a complex PowerPoint presentation to teach displacement vectors. Derek's use of the amusing analogy of how a snowman compared to trends in atomic radii proved to be an effective way to help students remember this concept. Kimberly's complex and interactive PowerPoint presentation on vectors helped her to better explain the lab on displacement vectors, something that was eluding her. THIS DOESN'T MAKE SENSE TO ME. How about, "...helped her better explain the abstract concept of how a moving object in a moving medium results in greater overall movement."

In regard to student engagement, participants used PowerPoint as a springboard to online animations and simulations. Libbie's lesson on populations proved to be an effective way of engaging students who are typically disinterested in the concepts. Her use of thought-provoking

images and animations captured her students' attention and led to a successful lesson. Josh's use of a self-created SMART Notebook lesson sparked his students' interest and was a successful way of reviewing atomic structure. Finally, both Derek and Gillian used PowerPoint presentations to help them transition from their respective lessons to interactive, online simulations. This proved to be a seamless transition and helped the lesson continue to flow.

Results showed that many participants used presentation software to teach inquiry-based lessons. Similar to Derek and Gillian, Vicki used presentation software to help her transition from a lesson on karyotyping to an engaging inquiry using an online simulation. Vicki's students enjoyed applying their newly acquired knowledge on karyotypes and genetic disorders to a fun and thought-provoking activity. Presentation software functioned as the primary piece of Kelly's inquiry-based lesson. Students determined if Lithops were living by viewing a series of engaging images. Kelly chose not to provide a definite answer to the question which made her lesson even more engaging.

The results from this investigation show that presentation software can be an effective way of teaching as long as users are prepared to use it appropriately. These results also show that presentation software can be used for more than just textual notes; it can radically change the way science is taught in secondary schools by bringing the outside world of video, images, simulations, analogies into the classroom. Is PowerPoint simply high-tech "talk and chalk"? Our results indicate that it doesn't have to be. Presentation software can help teachers do a better job planning and delivering instruction, and it can be used for reform-based science teaching and learning.

PLEASE HELP ME FINISH THIS CONCLUDING PARAGRAPH OK

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