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Study of the effectiveness of animations used in high school chemistry classes

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Study of the Effectiveness of Animations Used in High School Chemistry Classes

By

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ABSTRACT

This chemistry education research study explores the role of computer animations in a secondary chemistry classroom setting. This study examines the effects of animation among secondary science students regarding chemical concepts and focuses on the nature of matter, atomic structure, and classes of chemical reactions. This project observes the effectiveness of animation usage in a secondary science classroom setting, which was measured through student opinions and impressions as well as performance. It was hypothesized that students would retain more information through the use of animations in the classroom. The concepts covered included linking the macroscopic world of chemistry associated with the nature of matter and chemical reactions to the nano-realm of atomic structure and particle theory. Results for lecture-based learning showed that students benefited from the usage of animations coupled with lecture and students had a positive impression of the student-created animations during laboratory.
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Chapter 1. Introduction

Background

The education system in the United States has changed several times throughout history. The United States has dealt with issues such as women’s rights, segregation, the teaching of evolution, and special education. The Elementary and Secondary Education Act (ESEA) of 1965 created sweeping changes for public education (United States Department of Education, 2010). Its aim was to create equal access to education and establish higher standards and accountability for public education. In 1972, Title 9 added an amendment to ESEA that prohibited discrimination against women in education (United States Department of Education, 2010). In 1990, the Individuals with Disabilities Education Act (IDEA) was passed, designed to support and protect the education of students with special needs (United States Department of Education, 2010).

Recent attention has been drawn to U.S. students falling behind other countries in math and science. One set of data often referred to by politicians is from the Program for International Student Assessment (PISA). The PISA is an international assessment that focuses on 15-year-olds' abilities in reading literacy, mathematics literacy, and science literacy. PISA is coordinated by the Organization for Economic Cooperation and Development (OECD), a collaboration between governments of industrialized countries. PISA began in 2000, and tests are given every 3 years. Roughly 33 countries participate in the assessment.

In 2009, the average PISA science score of U.S. students was 502, whereas the OECD average was 501 (Hussar, 2008). This is an improvement over 2006 results, which show the US scored 474, lower than the average of 498. The 2009 results show slight
improvement on the science scores. “Among the 33 other OECD countries, 12 had higher average scores than the United States, 9 had lower average scores, and 12 had average scores that were not measurably different from the U.S. average score. The OECD countries with higher average scores than the United States were: Finland, Japan, Korea, New Zealand, Canada, Estonia, Australia, the Netherlands, Germany, Switzerland, the United Kingdom, and Slovenia. The OECD countries with lower average scores than the United States were: the Slovak Republic, Italy, Spain, Luxembourg, Greece, Israel, Turkey, Chile, and Mexico” (Hussar, 2010).

In addition to low science scores, only 70% of American students are expected to graduate in the traditional four years of high school (Amos, 2008). The statistics for minority students are much lower. For example, 57.8% of Hispanic, 55.3% of African American, and 50.6% of Native American students graduate on time. However, 77.6% of white students are expected to graduate on time. One suggestion for improving low-performing high schools is to provide students with the academic support and enrichment they need to succeed (Amos, 2008).

One form of support to raise student’s performance is legislative support. The latest legislation passed in 2002 designed to increase test scores and reduce dropout rates was labeled “No Child Left Behind.” The main goals of No Child Left Behind are that all students will achieve high academic standards by attaining proficiency or better in reading and mathematics by the 2013–2014 school year; highly qualified teachers will teach all students; all students will be educated in schools and classrooms that are safe, drug-free, and conducive to learning; all limited English proficient students will become proficient in
English; and all students will graduate from high school (Yell, 2006). This will all be accomplished by the year 2014. The aim of No Child Left Behind is “To close the achievement gap with accountability, flexibility, and choice, so that no child is left behind,” (United States Department of Education, 2010). In order to accomplish the goals of No Child Left Behind, teachers as well as students must work towards common objectives and take advantage of all available resources. One resource that is becoming more widely accepted and utilized is technology.

Electronic technology in today’s society is steadily and constantly advancing. Employees are expected to be current and up to date with the continuous development of technology. Educators have a wide variety of technology available to them. Lectures have turned into PowerPoint presentations and online notes. In addition, document cameras, which project documents that are not transparent, are available. There are also Smart Boards, which are similar to digital whiteboards. Classroom Performance Systems (CPS) are also used in classrooms to track and assess students’ progress instantaneously. Schools are learning facilities that are designed to prepare students for real-life experiences. Part of that preparation includes educating students on technology and using technology to meet the expectations of the teachers. Traditional teaching techniques, such as the use of overheads or the use of the chalkboard, are quickly becoming obsolete. Students, as well as teachers, need to be educated on the different effective technologies available to them.

Electronic technology has become a booming industry in the last 25 years. Computers are in every classroom, and students are expected to be knowledgeable about this
form of technology. The push for technology in classrooms stems from the increased use and dependence on technologies in a society where future jobs will include some form of technology.

Students in today’s schools are much different from their predecessors. Students today have a variety of technologies available to them at home. Entertainment such as television, Wii’s, computer games, iPods, and iPhones are quickly replacing older entertainment forms such as reading or outdoor activities. In the same sense, newer teaching techniques need to replace older teaching techniques in the science classroom, including in the chemistry classroom. Teachers need to be able to adapt their curriculum and delivery of material to the needs of the students. By adapting teaching methods to the needs of the students, it is hoped that students will be able to meet and exceed goals and expectations. It is necessary for education to change and adapt its curriculum in order to raise students’ understanding and improve standardized test scores.

Many students possess misconceptions in science. “Research has shown that children bring to lessons a lot of preexisting (alternative) conceptions about scientific phenomena that can interfere with students’ learning of correct scientific principles or concepts” (Haluk, 2004). A lot of research has indicated that students develop intuitive ideas about natural phenomena. Students interpret these new ideas based on their own older existing ideas (Palmer, 2001). As new information is learned, students tend to interpret new information from the viewpoint of these existing beliefs. This can compound any misinterpretations of the students. Teachers need to recognize these preconceived notions and overcome them in order for the student to be successful. Technology in the classroom could also help students
identify with science so they don’t feel so intimidated by the large concepts. Less intimidation could increase students’ confidence level and therefore increase student success.

**Justification**

The motivation of this study came from the need to incorporate technology in the classroom at Bendle High School in a motivating way. Students need to become more actively involved in their own education rather than relying constantly on the teacher’s instruction. By performing laboratories and creating their own animations, students take an active role and begin to take ownership of their own education.

**Purpose and Objective**

The purpose of this study was to examine the effects of animation among secondary science students regarding chemical concepts and focused on the nature of matter, atomic structure, and classes of chemical reactions. The two objectives of this research were to observe the effects of animation usage in a secondary science classroom setting and link concepts of the macroscopic world of chemistry associated with the nature of matter and chemical reactions to the nano-realm of atomic structure and particle theory.

**Hypothesis**

The hypothesis of this study was that secondary students in chemistry will benefit greatly through the usage of lecture-based learning and animations created by students in laboratory. Benefits would include a deeper comprehension of chemical concepts and a positive impression of both in-class animations and student-created animations.
Chapter 2. Literature Review

In 2009, more than 68% of all US households had internet access at home (United States Census Bureau, 2011). With the majority of students having computers at home, there is a need in education today to devise innovative ways of teaching as well as learning. This need has stemmed from the explosion of technology as well as the use of technology in the workforce (Cantor, 2002; Ezziiane, 2007). In the science classroom, the use of technology can be adapted through many forms. One use of technology in the science classroom that can be of use is animations.

With increased technological advances, animation has become a booming industry in the 20th century. Many colleges even offer degrees and courses on animation. For example, the California College of Arts offers degrees in animation that includes courses in Visual Storytelling, 3D Computer Animation, Character Design and Sound for Animation. Some feasible animations can take many forms including videos, clay-mations, flipbooks, stop motion, Adobe Flash, Autodesk 3D, or Microsoft PowerPoint. Animation in education has to be practical, affordable, and time conscientious. Clay-mations, flipbooks, and stop motion can be beneficial as they can be inexpensive but are time-consuming. Autodesk 3D and similar animation programs are often used by architects and engineers. However, these programs suffer from the disadvantage of being expensive and requiring intensive training. Another alternative is clearly needed for the secondary classroom. Microsoft PowerPoint is relatively inexpensive, is often already available, and offers animation features that are relatively easy to learn.
Animation can be beneficial to science-based learning when used, and it can be an excellent method for schools to incorporate technology (Dunsworth, Atkinson, 2007). Animations added into lecture or text-based learning, or integrated into an animation laboratory, can be beneficial to all learning styles in the science classroom. Lectures can have animations embedded throughout, which add a visual component to the lecture in addition to the auditory component. Animations laboratories are meant to supplement, but not replace, classroom and traditional laboratory learning (Spaziani, Fermann, & Vining, 1999). Two types of learners discussed by Felder and Soloman are active and reflective learners (Felder and Soloman, 2001). An active learner best retains information by actively participating in discussions or hands-on activities. A reflective learner best learns by thinking quietly and internal reasoning. In addition, active learners tend to work best in groups, whereas reflective learners tend to work independently. However, “sitting through lectures without getting to do anything physical but take notes is hard for both learning types, but particularly hard for active learners” (Felder and Soloman, 2001).

Other learning styles involve visual and verbal learners. For example, some students may learn best through listening to information presented verbally. Others are visual learners where pictures, diagrams, and demonstrations are most beneficial. Verbal learners benefit most through lecture-based learning, where the main method of learning is oral communication. However, “Everyone learns more when information is presented both visually and verbally” (Felder and Soloman, 2001). Utilizing animation with lecture can cover both the verbal learner and the visual learner (Glenberg & Langston, 1992; Mayer & Sims, 1994; Rieber, 1990). Animations allow for imagination and innovative approaches to
computer-based learning. “A cognitive approach to the design of practice would actively involve students in the instructional process. Cognitive practice would actually encourage mental conflicts to arise and would subsequently provide controlled opportunities for students to manage and resolve these conflicts with strategies such as informal hypothesis testing” (Rieber, 1990). If a teacher can incorporate lecture coupled with animation and animation activities, many different learning styles can be covered.

Jean Piaget is a famous developmental psychologist who observed various learning stages of human development. Piaget believed in four different developmental stages in humans which affects how and what they learn (Beilin, 1992). The first stage is a sensorimotor stage from birth to age two. In this stage, Piaget believed that children experience the world through movement and senses. He also believed that children are extremely egocentric and incapable of perceiving the world from another person’s point of view. The second stage is a preoperational stage from age two to seven. In this stage, the egocentric nature of the child diminishes but the child is still incapable of logical thinking. The third stage is a concrete operational stage from age seven to twelve. In this stage, children are no longer egocentric and begin to think logically, but only with aids. The final developmental stage, according to Piaget, is a formal operation stage from age twelve and above (Beilin, 1992). In this stage, children are able to think logically and abstractly. The students participating in this research should all be in the formal operation stage.

There are four main approaches to lecture using animation. The first is text only presented with no animation presented. The second approach is one or more animations followed by text or lecture. A third approach is text followed by animation. An example is a
text passage followed by one or more animations. In the fourth approach, the text and the animation were presented simultaneously (Sperling, Seyedmonir, Aleksic, Meadows, 2003). In previous research using all four approaches to animation use, no differences were observed for overall recall of material (Sperling et al., 2003). However, results indicated that groups who received animation and text sequentially remembered more than either the text only or the text and animation presented concurrently (Sperling et al., 2003). Moreover, if used improperly, animation can be distracting for students (Rieber, 1996). For example, if used for cosmetic purposes only, animations can distract student attention from other more important material. Very little previous research has been conducted on students’ responses to animations or building their own animations in the secondary science classroom.

Instructors need to expel any preconceptions that science is difficult or intimidating for students (Rudd, 1984). This type of thinking can alienate students from science. Many authors have drawn attention to the lack of connections between their students and the subject (Rudd, 1984). Instructors need to find a way to relate the subject to the students. Technology is one way instructors can do this. By changing the way information is presented and integrating technology, instructors can relate the subject to the student and therefore relieve the intimidating notion of science (Rudd, 1984). Most teachers agree that technology in the classroom is a necessity. New techniques in presentation style can accommodate the need for technology as well as relate the subject of science to the students.

Data show that when students are motivated, they have greater achievement in academics (Uguoglu, 1979; Gottfried et al., 2007). Studies have shown that from childhood to adolescence across diverse populations, motivation is linked to higher competence and
greater academic achievement (Gottfried et al., 2007). Furthermore, students have lower academic anxiety and a more positive perception of their competency (Gottfried et al., 2007). “Because of their replicated correlations with achievement and potential for psychometric improvement, motivation measures clearly deserve inclusion in general research on classroom learning along with other factors to determine the causal directions and weights for the factors as well as point to the most effective ways to make learning more productive” (Uguoglu, 1979). Motivation can be a powerful tool for teachers in the classroom (Elliot & Dweck, 2005). “Motivation is a key component in learning. Not only is it the case that motivation helps learning, it is essential for learning” (Hein, 1991).

Animation is one way to incorporate technology into the classroom. Some science teachers have reservations about technology usage in the science classroom. One main concern of animation in the classroom is teachers’ lack of experience using technology (Donovan, Hartley & Strudler, 2007). Some teachers may not feel comfortable writing animation schemes and could wrongly present the information. In addition, animations could be very time-consuming for teachers. If animations are too time-consuming or too challenging, teachers may fall back on their old style of teaching such as the use of chalk boards.

Although animations can be an excellent learning tool in the classroom, the cost of some of the technology can be discouraging to school districts (AL-Bataineh & Brooks, 2003). Technology requires a constant investment to update or upgrade to new software. This can be frustrating not only for teachers, but also for administrators because they must fund these expensive programs. Some other animations such as clay-mations can require
more expensive camera equipment. Many animation programs can be very costly and funding can be limited. In addition, technology develops very quickly and programs become outdated very quickly. Poor or rural districts may not have funding available for more expensive animation programs. However, an easier transition for teachers is to use animations that can be created in PowerPoint. This method would allow teachers to still use their previous lecture techniques but incorporate some newer technology.

Another major disadvantage of learning through animation is the high order cognitive learning. Some studies suggest that students using animation programs do not show advancement in cognitive learning (Dunsworth & Atkinson, 2005; Resa & Jones, 2007). This can be frustrating for educators as a major goal for teachers is to enable their students to think independently. This previous research is the major discouraging aspect of animation usage. However, very little research has been published in the fields of education or chemistry regarding animations in the high school chemistry curriculum. The results of this thesis work could offer new insight into animations in the high school science curriculum.

According to one study, any misconceptions that appeared after viewing animations resulted from the retention of previous misconceptions (Kelly & Jones, 2007). Although this previous research offers benefits to animation, one downfall is overcoming previous misconceptions by students. Another cause of misconceptions arising from the use of animations in lecture is the inaccurate or misleading manner of the animations, particularly with the size of atoms or ions (Kelly & Jones, 2007). In addition, Kelly and Jones suggest that smaller group discussion may help students self-regulate and correct their own mistakes in their animations. This could reduce the number of misconceptions that are carried over.
Another problem-solving method to dispel any misconceptions could be to use animations at an earlier age, perhaps during elementary school or middle school. This could reduce the misconceptions that carry over into secondary school.

Misconceptions and preconceptions are a constant battle for all teachers, including science teachers (Ozmen, 2004). If a student develops a misconception, this can lead to compounded misconceptions with new information added. “Research has shown that children bring to lessons a lot of preexisting (alternative) conceptions about scientific phenomena that can interfere with students’ learning of correct scientific principles or concepts” (Ozmen, 2004). According to the constructivist model, “Knowledge is constructed in the mind of the learner” (Bodner, 1986). According to the constructivist’s view, learning is a compounding process where each new piece of information is built on the last piece of information. As students learn, they try to organize their experiences in terms of preexisting mental scheme. According to Piaget, assimilation applies a preexisting scheme to interpret new information. Accommodation is the process by which existing structures are modified in order to fit newly assimilated data. “Once we have constructed this knowledge, simply being told that we are wrong is not enough to make us change our (mis)conceptions,” (Bodner, 1986). In order to clear up misconceptions, a new concept must be constructed that better explains our experiences. Although this thesis does not focus specifically on the effects of animations on misconceptions, this work can offer teachers an excellent way to supplement classroom and laboratory learning.
Chapter 3. Methods

Participants were students at Bendle High School in Burton, Michigan, during the school years from 2009-2010. Bendle High School is located near Flint, Michigan, and contains grades 9-12. As of February 2010, there are 361 students at Bendle High School: 187 males (51.8%) and 174 females (48.2%). In addition there are 59 students (16.3 %) who qualify for special education services. Two hundred sixty nine students (72.3%) qualify for free or reduced lunch. Four students (1.1%) were classified as homeless, and one student was classified as ESL (English as Second Language).

The average ACT for the 11th grade students during the 2009 and 2010 year were 18.1 and 18.7, respectively. Bendle High School has a graduation rate of 81% for the past two years. This is roughly a 19% drop-out rate, slightly lower than the national average. During 2009 and 2010, approximately 48% and 40%, respectively of seniors went on to some form of college.

Students participating in the research were either taking Chemistry 1 or Introduction to Chemistry. Course descriptions are shown in Table 1. Students were asked to voluntarily participate in the study. A consent form for all students was sent home to be signed by a parent or guardian and returned. The consent form used is found in Appendix A. An explanation of the study was included in the consent form. Students were allowed to withdraw from the study at anytime during the course or after it had finished. This research was conducted over four trimesters which included four Chemistry 1 sections and seven Introduction to Chemistry sections.
Under the privacy act Family Educational Rights and Privacy ACT (FERPA), individual scores and grades cannot be disclosed. However, general performance assessments of students will be discussed. Generalizations regarding the success rates of students will also be discussed.

Introduction to Chemistry students used the book “Physical Science: Concepts in Action,” which is published by Prentice Hall and written by Wysession, Frank, and Yancoppoulos. The edition used was printed in 2009. This book has links to online resources that students can use. Some resources are websites the students can visit to support their learning. For example, the chapter on atomic structure has links to websites that show different energy levels of the Bohr model of the atom. These websites are too advanced for Introduction to Chemistry students but could be useful for Chemistry 1 students.

Chemistry 1 students used the book “Chemistry,” which is published by Prentice Hall and written by Wilbraham, Staley, Matta, and Waterman. The edition used was printed in 2008. This book also provides web resources that support students with their learning. There are web resources available for students, showing types of chemical reactions as well as the Bohr model of the atom with different energy levels.

Introduction to Chemistry is primarily a 9th grade course. However, there are some 10th and 11th grade students who have to retake the course due to a previous failure. Chemistry 1 is primarily an 11th grade course. However, there are some advanced 10th grade students and some 12th graders who take this course. The course requirements and course descriptions are shown in Table 1.
Table 1. Course descriptions Introduction to Chemistry and Chemistry 1.

<table>
<thead>
<tr>
<th>Course</th>
<th>Grade</th>
<th>Prerequisite</th>
<th>Course description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Chemistry</td>
<td>9</td>
<td>None</td>
<td>The goal of Introduction to Chemistry is to reinforce and extend a variety of science skills and to encourage critical thinking. Students will be introduced to the basics of chemistry. Topics include properties of elements, atomic structure, bonding, acids and bases and chemical reactions. This course is part two of the 9th grade physical science requirement.</td>
</tr>
<tr>
<td>Chemistry 1</td>
<td>10-12</td>
<td>Algebra 1</td>
<td>This is a college prep science course intended for the students with a reasonably strong math background and college interest. We cover a wide variety of chemistry areas in organic and inorganic chemistry. Heavy emphasis is placed on class activities and notes with little emphasis on the book. Much lab work is used to supplement written works.</td>
</tr>
</tbody>
</table>

Animations were initially created and embedded into previously existing lectures. Topics involved the subjects of matter, atomic structure, and classes of chemical reactions. To begin, a pre-survey was distributed to students to assess previous knowledge of the topic. A sample pre-survey and post-survey are in Appendix B and Appendix C. Lecture over a topic was carried out with the animation embedded in the lecture. The animation was discussed in detail with the students. Generally, homework or questions would be assigned to the students to support their learning. In addition, a traditional laboratory and an animation laboratory would be completed. Once the lecture and homework were completed, a brief post-survey was used to assess the retention rate of the material. After the post-survey, a formal test was given to the students. The post-surveys and formal tests were completed.
within two weeks of the animations presented with lecture. The reflections were completed within 48 hours of the laboratory as to keep the laboratory fresh in the students’ minds. Details on which animations were incorporated into the courses are organized in Table 2.

**Table 2. Lecture animations and laboratory animations and their usage.**

<table>
<thead>
<tr>
<th>Subject of animation</th>
<th>Course</th>
<th>Lecture-embedded</th>
<th>Student-created animation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homogenous vs. Heterogeneous Mixtures</td>
<td>Introduction to Chemistry</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Atomic Structure</td>
<td>Introduction to Chemistry</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>States of Matter</td>
<td>Introduction to Chemistry</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Classes of Chemical Reactions</td>
<td>Introduction to Chemistry</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Chemistry 1</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Surveys and assessments including pre-surveys and post-surveys were used initially to determine students’ retention of material and their interpretations of animations used with lecture. Discussions with the students after watching the lecture-embedded animation indicated interest in creating their own animations and were incorporated into the chapter. Discussions with students indicated that the students felt overwhelmed with pre-surveys, post-surveys, quizzes, traditional laboratories, animation laboratories, notes, reviews, vocabulary reviews, and tests. Because of the overwhelming feeling from students,
pre-surveys and post-surveys were used for approximately two trimesters, each containing one course, before being discontinued. Since the pre-surveys did not assess students’ impressions of animations, their results are not included here. In order to continue with the research, data collection focused mainly on lecture animations, discussions of lecture animations, animation laboratories, and laboratory reflections. Originally, the control groups being used were previous Introduction to Chemistry courses and Chemistry 1 courses. However, the pre- and post-surveys regarding animations in lecture were eliminated quickly due to students expressing a heavy workload. Because very little data were collected through pre-surveys and post-surveys, the data from the control group were not used.

**Animations Embedded in Lecture**

Computer animations were incorporated into lecture notes. The areas of animation used in lecture were mixtures, atomic structure, ionization, states of matter, and chemical reactions including synthesis, decomposition, single replacement, double replacement, and acid/base. These animations were chosen as they were easy to create in PowerPoint, time-efficient to create, and illustrated the goals of the chapter well.

**Sample Animation for Homogeneous vs. Heterogeneous Mixtures**

One animation that was incorporated into lecture was an animation about homogeneous and heterogeneous mixtures. This animation showed the difference between homogenous and heterogeneous mixtures. The example in lecture had a container filled with white spheres which represented the homogenous mixture. A different container that held
black spheres is mixed with the white spheres, which creates a heterogeneous mixture. A before and after screen shot is shown below.

Figure 1. Screen shot of animation on homogeneous mixtures prior to mixing.
Another animation used in lecture was one representing a decomposition and synthesis reaction. This was an excellent animation that was eventually incorporated into an animation laboratory. In Figure 3, the decomposition of hydrogen peroxide is shown prior to the animation. During the animation, hydrogen breaks away from oxygen. The animation shows the breakdown of hydrogen peroxide into hydrogen and oxygen, which is shown in Figure 4. Because this section focuses on the classes of chemical reaction, no bond formation is represented in the animation. In Figure 5, the synthesis of hydrogen peroxide is shown. The animation in Figure 5 shows the combination of hydrogen and oxygen to form hydrogen peroxide.
Figure 3. Animation involving the decomposition of hydrogen peroxide before animation.

Figure 4. Animation involving the decomposition of hydrogen peroxide after animation.
Synthesis

During a synthesis reaction, TWO OR MORE reactants combine into ONE product.

\[ \text{H}_2 + \text{O}_2 = \text{H}_2\text{O}_2 \]

Figure 5. Animation involving the synthesis of hydrogen peroxide using hydrogen and oxygen.

Student Surveys

Pre-surveys and post-surveys can be seen in Appendices B and C. As mentioned, pre-surveys and post-surveys were used for approximately two trimesters, each containing one course, before being discontinued. Because pre-surveys did not assess students’ impressions of animations, results are not included here. Post-surveys were used to evaluate the students’ opinions of animations embedded into lecture and are therefore included in the results. Also, post-survey questions were used to assess which methods used in the classroom helped students learn the best according to their learning style. Likert scales were used in both pre-surveys and post-surveys. Because post-surveys used Likert scales, they were interpreted quantitatively. In Appendix C, questions 2 and 10 were essentially the same issue, but reworded in order to check for repeatability. Question 2 stated “The animations
used in the classroom help me remember the material.” Question 10 stated “Animations helped me remember atomic structure.”

In addition, pre-survey and post-survey questions included all levels of Bloom’s taxonomy. Bloom’s taxonomy is a classification of different learning objectives that educators set for students (Anderson & Sosniak, 1994). Bloom created six levels of intellectual behavior including knowledge, comprehension, analysis, application, synthesis, and evaluation. The lowest level is simple recognition of facts (knowledge), and the highest level includes unique communication (evaluation) (Anderson & Sosniak, 1994). Animations themselves focused mainly on synthesis, which included constructing and designing atoms. Many post-laboratory questions involved a range of questions from knowledge to evaluation. Samples of animation laboratories with post-laboratory questions can be viewed in Appendix D. A sample animation reflection can be viewed in Appendix E.

**Student Animation Laboratories**

Introduction to Chemistry students created animations for states of matter, atomic structure, and types of chemical reactions. These animations were chosen as they were also easy to create in PowerPoint, time-efficient to create, and illustrated the goals of the chapter well. Through lecture and the states of matter animation laboratory, students were able to compare and contrast the basic movement of solid molecules, liquid molecules, and gaseous molecules. The goals of the teacher were important because they were used to determine long-term retention of the material. The goals were used to assess the effects of the use of animation in the classroom. Goals of this animation laboratory are as follows:
• Students will comprehend the motion of the molecules of solids, liquids, and gases.

• Students will understand that solid molecules still vibrate together even though their molecules are tightly packed together and the molecules are greatly attracted to each other.

• Students will also realize that liquid molecules are packed almost as tightly as solids but are able to move freely past each other.

• Students will grasp that gaseous molecules move fast and in all directions and have very little attraction to each other.

• Students will be able to deduce that because of their motion in all directions, gases have no definite shape or volume.

This is an introductory course, so the goals of this laboratory are simple. The goal is for students to simply understand the basic movement of molecules in the three states of matter. The animation laboratory created by the students covered Michigan science prerequisite P5.p1A, “Draw a picture of the particles of an element or compound as a solid, liquid, and gas,” and Michigan standard C4.3A, “Recognize that substances that are solid at room temperature have stronger attractive forces than liquids at room temperature, which have stronger attractive forces than gases at room temperature” (Michigan Department of Education, 2001). During lecture, the effects of temperature on molecules were discussed. However, during the states of matter laboratory, temperature was not incorporated.
Introduction to Chemistry students also created an atomic structure animation. Atomic structure has evolved using several models throughout history. Students are educated on the history of atomic theory starting with Dalton’s model of the atom, to Thompson’s Plum pudding model, to Rutherford’s atom, to the Bohr model of the atom. Students then completed the animation laboratory, based on the Bohr model of the atom. After the animation laboratory, students are introduced to the current Electron Cloud model of the atom. The Electron Cloud model of the atom is briefly discussed in Introduction to Chemistry and more detail is covered in advanced chemistry courses. Although the Bohr model of the atom involves energy levels, the students are not expected to know the different energy levels, simply that they exist. Goals of this animation laboratory are listed below:

- Students will calculate the number of protons, neutrons, and electrons in an atom.
- Students will properly create the movement of electrons around the nucleus of the atom.
- Students will calculate atomic number and mass number of an element.

The atomic structure animation laboratory covered Michigan standard C4.8A, “Identify the location, relative mass, and charge for electrons, protons, and neutrons” and C4.8B, “Describe the atom as mostly empty space with an extremely small, dense nucleus consisting of the protons and neutrons and an electron cloud surrounding the nucleus” (Michigan Department of Education, 2001).

Both Introduction to Chemistry and Chemistry 1 courses completed animations on types of chemical reactions. Introduction to Chemistry is introduced to five main types of
reactions: single replacement reactions, double replacement reactions, combustion reactions, combination reactions, and decomposition reactions. In addition to these five main reactions, Chemistry 1 classes are introduced to acid/base reactions. Chemistry 1 students are required to memorize all strong acids and strong bases in order to properly identify an acid/base reaction. Goals of this animation laboratory are listed below:

- Introduction to Chemistry students will predict the products of a single replacement reaction and a double replacement reaction.

- Chemistry 1 students will predict the product of two of the following: a single replacement reaction, a double replacement reaction, a synthesis reaction, a decomposition reaction, or an acid/base reaction. The students needed to incorporate charges on ions to predict the proper products.

All students had a basic knowledge of balancing reactions, but balancing reactions was not a priority in this laboratory. The animation laboratory for Introduction to Chemistry covered Michigan standard C5.6b, “Predict single replacement reactions” (Michigan Department of Education, 2001). Chemistry 1 students also completed standard C5.6b and standard C5.7B, “Predict products of an acid-base neutralization” (Michigan Department of Education, 2001).

One prerequisite to the chemistry standards consists of matter and mixtures. This material covers the State of Michigan standard prerequisite P4.p2A, “Distinguish between an element, compound, or mixture based on drawings or formulae” (Michigan Department of Education, 2001). Because this is a prerequisite standard, all students should bring this knowledge to high school science classes. However, to reiterate this material, an animation
was incorporated into a lecture for Introduction to Chemistry. This animation was on homogeneous and heterogeneous mixtures. This animation is shown in Figures 1 and 2. Although this standard is simply a prerequisite to the Chemistry standards, it is still covered in Introduction to Chemistry courses.

**Student Reflections**

The results of animation reflections completed by the students were collected through written answers during class time, the quality of responses provided on animation laboratory reports and discussions with students. Data on the reflections were gathered qualitatively, and all questions on all surveys and reflections were designed to have little ambiguity and be very direct using basic language. This was accomplished by using simple and familiar terminology. In addition, questions were designed not to imply an answer. Instead, they were designed to be unbiased.

Students were briefed on the reflections, and emphasis was put on the fact that their surveys would be treated as anonymous. Students were told that their honest opinion was important in structuring their learning style. Also, students were told repeatedly that feelings of the teacher would not be “hurt” in any way and that their honest opinion will be greatly valued. In addition, students were informed that their opinion would neither hurt nor help their grade. This was done in order to evoke truthful responses from students.

Animation laboratories were laboratories where students would create animations using Microsoft PowerPoint 2007. Microsoft PowerPoint was chosen as the primary animation creator because all school computers had the program as well as its frequent use
within home computers. All computers used by the students were Hewlett Packard and utilized Windows XP. Prior to the start to the school year, all students have to sign an “Acceptable Computer Use” agreement for use on any school computer. This agreement states that students will only use the laptops for school purposes and for appropriate reasons.

Animation laboratories and reflections were used throughout both Introduction to Chemistry and Chemistry 1 courses. The students were given the assignments and the assignment was explained in detail. The students then completed the assignment and brought the assignment to the teacher to check for completion. If changes were needed, students were given the option of changing the mistakes or turning the assignment in “as is.” This gave the student the option of making the proper corrections prior to turning in the laboratory. The option of correcting the assignment was done for two reasons. The first reason was to increase students’ understanding and correct any mistakes made in order to increase understanding. The second reason was to increase students’ success in the laboratory.

Animation laboratories were graded using rubrics. A rubric is a scoring guide that evaluates the student’s performance based on the addition of points from various criteria established by the teacher. Rubrics make the expectations of the teacher very clear with little ambiguity. Rubrics tell students exactly what is expected of them, which avoids any uncertainty. In addition, students can also better understand where and why they lost points in order to work on their strengths and weaknesses. Two rubrics are shown in Appendix D and Appendix E.
When students created their own animations within PowerPoint, they received approval as to the accuracy of their animation and were required to make corrections for any errors. In addition, students answered post-lab questions in order to solidify and reiterate the material. Students were then asked questions in a survey about animations used in-class and a reflection on laboratories where they created their own animations. This was done to check for retention of the material during animations embedded in lecture and students’ overall impression of animations.
Chapter 4. Results and Discussion

Post-Survey Results for Lecture-Embedded Animations

Data for 43 students in Introduction to Chemistry were collected. Because students felt overwhelmed with a continuous set of surveys to complete, post-survey data, collected for a short time, was discontinued and instead the subjective feelings of students related to animations was assessed by the teacher through informal discussions. These informal discussions were used after the pre-surveys and post-surveys were discontinued. One of the main focus points of these informal discussions was to determine how students felt about the lecture animations and if they helped the students visualize an atom. In addition, discussions with students regarding lecture notes were conducted to determine how students felt about the lecture animations.
Table 3. Data results for 43 Introduction to Chemistry students post-survey on atomic structure.

<table>
<thead>
<tr>
<th>Question number</th>
<th>Topic</th>
<th>Question</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Comfort</td>
<td>I feel comfortable with atomic structure</td>
<td>23.8%</td>
<td>40.5%</td>
<td>31.0%</td>
<td>4.8%</td>
<td>0.0%</td>
</tr>
<tr>
<td>2</td>
<td>Animation (visual)</td>
<td>The animations used in the classroom helped me</td>
<td>33.3%</td>
<td>47.6%</td>
<td>19.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>3</td>
<td>Problem-solving</td>
<td>Sample problems help me understand the material more than animations.</td>
<td>11.9%</td>
<td>26.2%</td>
<td>33.3%</td>
<td>21.4%</td>
<td>7.1%</td>
</tr>
<tr>
<td>4</td>
<td>Animation (visual)</td>
<td>Animations help me visualize an atom.</td>
<td>54.8%</td>
<td>38.1%</td>
<td>7.1%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>5</td>
<td>Listening (auditory)</td>
<td>Hearing the teacher talk helps me visualize an atom</td>
<td>9.5%</td>
<td>33.3%</td>
<td>33.3%</td>
<td>21.4%</td>
<td>2.4%</td>
</tr>
<tr>
<td>6</td>
<td>Comfort</td>
<td>I am ready for a test on atomic structure</td>
<td>11.9%</td>
<td>23.8%</td>
<td>38.1%</td>
<td>19.0%</td>
<td>7.1%</td>
</tr>
<tr>
<td>7</td>
<td>Listening (auditory)</td>
<td>Hearing the teacher talk helps me remember atomic structure.</td>
<td>9.5%</td>
<td>21.4%</td>
<td>47.6%</td>
<td>19.0%</td>
<td>2.4%</td>
</tr>
<tr>
<td>8</td>
<td>Note-taking</td>
<td>Taking notes help me remember atomic structure.</td>
<td>9.5%</td>
<td>50.0%</td>
<td>28.6</td>
<td>7.1%</td>
<td>4.8%</td>
</tr>
<tr>
<td>9</td>
<td>Interactive</td>
<td>Working with other students helps me remember atomic structure.</td>
<td>31.0%</td>
<td>33.3%</td>
<td>31.0%</td>
<td>2.4%</td>
<td>0.0%</td>
</tr>
<tr>
<td>10</td>
<td>Animation (visual)</td>
<td>Animations helped me remember atomic structure.</td>
<td>31.0%</td>
<td>50.0%</td>
<td>16.7%</td>
<td>2.4%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>
The information presented in Table 3 can provide an abundance of information about students’ learning styles, self-confidence, and writing. First, learning styles of the students can be understood through questions number 2, 4, 5, 7, 9, and 10. Questions number 5 and 7 indicate around 45% of students have a strong audio learning style. Questions 2, 4, and 10 show that most students have an overwhelming visual learning style. Question number 7 also shows that listening to the teacher was, to some extent, beneficial to students. Working sample problems helped only about a third of the class learn, while in question 9, students indicated that group work helped them learn.

Information on self-confidence can also be extracted from the data in Table 3. For questions 1, 2, 4, 8, 9, and 10, students overwhelmingly agreed with the question statement. Questions 2, 4, and 10 supports the conclusion that students believed animations helped them learn. Responses to question number 1 show that students gained confidence and felt comfortable with the material. However, although 64% of students felt confident, only about 36% of students felt ready for an examination (question 6). Perhaps the difference of 28% indicates the number of students with test anxiety. When looking at the overall test grades from the course, the average test score for the students was roughly equal to the students’ confidence level, about 65%.

Last, information on writing can be deduced from Table 3. Students overwhelming indicated that taking notes helped them learn (question 8). Theorists agree that writing can be a valuable tool for learning content, not just a way to report what has been learned (Reaves, 1993). In addition, students retained more of the information they learned when
using writing techniques in the classroom (Reaves, 1993). The data in Table 3 support previous research stating that writing helps students retain information.

Another way to interpret the data from Table 3 is to place the data on a scale of 1-5, 5 being strongly agree and 1 being strongly disagree. The results are organized in Table 4. This incorporates the average of students’ responses.

**Table 4. Responses of 43 Introduction to Chemistry students regarding post-survey based on a 1-5 scale.**

<table>
<thead>
<tr>
<th>Question number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>4.000</td>
<td>4.000</td>
<td>3.000</td>
<td>4.000</td>
<td>3.000</td>
<td>3.000</td>
<td>3.000</td>
<td>4.000</td>
<td>4.000</td>
<td>4.000</td>
</tr>
<tr>
<td>Mode</td>
<td>4.000</td>
<td>4.000</td>
<td>3.000</td>
<td>5.000</td>
<td>3.000</td>
<td>3.000</td>
<td>3.000</td>
<td>4.000</td>
<td>3.000</td>
<td>4.000</td>
</tr>
<tr>
<td>Standard Dev.</td>
<td>0.8433</td>
<td>0.7095</td>
<td>1.096</td>
<td>0.6250</td>
<td>0.9773</td>
<td>1.082</td>
<td>1.081</td>
<td>0.9774</td>
<td>0.9035</td>
<td>0.8676</td>
</tr>
</tbody>
</table>

Often times, neutral answers do not offer much insight as to overall student responses. Another way to interpret the data is to eliminate neutral answers and place them on a scale of 1-5, 5 being strongly agree and 1 being strongly disagree. Neutral answers given by students were eliminated in the following table. The data for non-neutral answers only are shown in Table 5 below.
Table 5. Non-neutral Introduction to Chemistry responses to post-survey based on a 1-5 scale.

<table>
<thead>
<tr>
<th>Question number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>4.000</td>
<td>4.000</td>
<td>4.000</td>
<td>5.000</td>
<td>4.000</td>
<td>4.000</td>
<td>4.000</td>
<td>4.000</td>
<td>4.000</td>
<td>4.000</td>
</tr>
<tr>
<td>Mode</td>
<td>4.000</td>
<td>4.000</td>
<td>4.000</td>
<td>5.000</td>
<td>4.000</td>
<td>4.000</td>
<td>4.000</td>
<td>4.000</td>
<td>4.000</td>
<td>4.000</td>
</tr>
<tr>
<td>Standard Dev.</td>
<td>0.7602</td>
<td>0.4922</td>
<td>1.334</td>
<td>0.4959</td>
<td>1.175</td>
<td>1.367</td>
<td>1.306</td>
<td>0.9798</td>
<td>0.6809</td>
<td>0.6220</td>
</tr>
</tbody>
</table>

The data from Table 4 represent the data with neutral answers included. Upon analyzing question 2 from Table 4, students indicated that they remembered the material best through animations in lecture with an average score of 4.142. Question number 9 came in after question number 2 with a score of 3.904. From question number 9, students indicate that working in groups also helped them remember atomic structure. This indicates that students enjoy collaborative work environments. When discussing why students liked working in groups, they indicated that sometimes a friend could clear up questions they had. In addition, students mentioned that group work was more relaxing than working independently and they felt more comfortable around others.

With a score of 3.571 and 3.261, note-taking and hearing the teacher talk came in next, respectively. Students clearly indicated that animations in lecture helped them best
remember the material. Hearing the teacher talk was the least effective in helping students remember material. This indicates that students are more visual learners rather than auditory learners. In addition, students indicated that sample problems did not significantly help them understand the material more than animations. Students also indicated that animations significantly helped them visualize an atom, whereas hearing the teacher talk received a neutral response. These results indicated that students felt that animations helped them better understand and visualize atoms rather than hearing the teacher talk or note-taking. Again, this supports the inference that students are visual learners rather than auditory learners.

The data from Table 5 represent the data without neutral answers included. By eliminating neutral answers, the data can be reduced to students who felt stronger about the issue. Questions 2, 3, 4, and 10 ask directly about animations used in the class and the students’ responses to those animations. Comparing data from Table 3 and 4, the averages from questions 2, 3, 4, and 10 all increased. Question 2 increased from 4.142 to 4.412. Question 3 increased from 3.190 to 3.286. Question 4 increased from 4.452 to 4.564. Question 10 increased from 4.095 to 4.314. Regarding question about animation, clearly the largest jump was question 10. Question 10 asked if animations helped them remember atomic structure. This is a significant question because it assessed the students’ opinion of the retention of the data using animations.

In analyzing informal teacher-student discussion, students repeatedly indicated that animations used during lecture helped them visualize the concept in question. For example, several students described how single replacement and double replacement reactions were further clarified when an animation was shown embedded in lecture. To clarify, the
animation is embedded into the lecture and shown simultaneously with lecture. In discussing when students would “click” and understand the structure of atoms, most students reported having the “aha” moment when animations were used in lecture. The “aha” moment is a phrase commonly used by teachers to describe the moment when students finally understand a concept taught in class. Many students indicated that although they read the material in the book and listened to lecture, it didn’t solidify the concepts. However, when an animation was used, it helped bring together the pieces together for the students. The use of animations in lecture greatly benefited students as they had an overall positive impression of animations used in conjunction with lecture. This could be due to the visual nature of animations. The effectiveness of animations in the secondary science classroom appears to be beneficial to students through the visual nature of animations and a positive impression of animations.

**Animation Laboratory Reflections**

Animation laboratories were used to solidify and assist students learning. An animation laboratory completed by Introduction to Chemistry students covered atomic structure. The laboratory handout to be completed by the students is shown in Appendix D. An animation laboratory completed by Chemistry 1 students covered types of chemical reactions, and the laboratory handout is shown in Appendix E. Note that although Chemistry 1 covers balancing reactions, this animation focused only on types of reactions. Post laboratory question #3 asks students to classify reactions but does not have them balance the reactions.
Student Reflections from the Introduction to Chemistry Course

One method of assessing students’ impressions of animation laboratories is through a laboratory reflection given to students following each animation laboratory. The reflection handout is shown in Appendix F. Reflections are intended to be a short evaluation of students’ impression of the animation laboratory. Reflection data for Introduction to Chemistry has been summarized in Table 6. In the course Introduction to Chemistry, 130 students participated over 4 trimesters. For each individual laboratory, not all of the 130 students completed the reflections due to absenteeism and the voluntary nature of the activity. The first question asked to students was “Did you enjoy the animation lab?” The data for this question for Introduction to Chemistry students are shown in Table 6.

Table 6. Responses from 130 Introduction to Chemistry students regarding the question, “Did you enjoy the animation lab?”

<table>
<thead>
<tr>
<th>States of Matter</th>
<th>Percentage of students who answered “Yes”</th>
<th>Percentage of students who answered “No” or were neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>States of Matter</td>
<td>87.8%</td>
<td>12.2%</td>
</tr>
</tbody>
</table>

| Atomic Structure | 83.5%                                      | 16.5%                                                  |
| Types of Reactions | 94.2%                                      | 5.8%                                                   |
The data from Table 6 overwhelmingly indicate that students enjoyed the animation laboratories. Students gave many reasons for their positive impression of the laboratories. Examples are shown below.

- “We were allowed to work in groups”
- “It helped me remember the material”
- “It was fun and easy”
- “Finally learned how to calculate protons and electrons”
- “It was a break from work”
- “It was pretty good, I liked it because I got out of other work”
- “I understood what I was doing”

A small percentage of students, however, did not enjoy the animation laboratory and gave reasons. Examples are shown below.

- “Too difficult”
- “I don’t like to use the computers”
- “It was a good lab, but I did all the work”
- “I didn’t finish it”
- “Don’t like animation labs”
- “It was boring”
- “Not fun”
Some constructive criticism that students gave to improve or modify the laboratory included doing included more animations, fewer animations, easier animation, more complex animations, and nothing. The criticism by the students was split on ways to improve.

Another important reflection question was if the students wanted to do another animation laboratory. The question asked was “Would you like to do another animation lab? If so, do you have any ideas for another lab”? The intent behind this question was for students to offer ideas for additional animation laboratories for past or future topics in chemistry. This question was specifically asked because it is a good indicator if students really enjoyed the laboratory or simply tolerated it. The results are shown in Table 7.

**Table 7. Responses from 130 Introduction to Chemistry students regarding laboratory data on the question “Would you like to do another animation lab?”**

<table>
<thead>
<tr>
<th></th>
<th>Percentage of students who answered “Yes”</th>
<th>Percentage of students who answered “No” or were neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>State of Matter</td>
<td>74.3%</td>
<td>25.7%</td>
</tr>
<tr>
<td>Atomic Structure</td>
<td>81.7%</td>
<td>18.3%</td>
</tr>
<tr>
<td>Types of Reactions</td>
<td>91.9%</td>
<td>8.1%</td>
</tr>
</tbody>
</table>

Again, the data from Table 7 overwhelmingly indicate that students enjoyed the laboratory and would be willing to do another laboratory. This adds credibility to the initial
question of “Did you enjoy the animation lab?” It also indicates that students genuinely enjoyed animations laboratories and were interested in creating more of their own animations. Moreover, the percentage of students who enjoyed the laboratories went up consistently through each laboratory. This could indicate that students are becoming more familiar with how to create these animations. It supports the statement that the students genuinely enjoyed animations laboratories.

**Student Reflections from the Chemistry 1 Course**

Chemistry 1 students were also asked similar questions. There were significantly fewer students who participated in the study from Chemistry 1. Roughly 56 students participated over 4 trimesters. Although 56 students agreed to participate for the research, not all students actually completed every laboratory. Again, absenteeism is a problem in the Bendle Public School district, and tracking students down to make up laboratories or fill out reflections is challenging. At other times, some students simply refused to do the assignment. In addition, fewer data were collected for Chemistry 1 students as there was only one type of animation laboratory completed by the students. The animation laboratory involved chemical reactions. Results for this laboratory are shown in Table 8 and 9.
Table 8. Chemistry 1 laboratory data collected from 56 Chemistry 1 students on the question “Did you enjoy the animation lab?”

<table>
<thead>
<tr>
<th></th>
<th>Percentage of students who answered “Yes”</th>
<th>Percentage of students who answered “No” or were neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Reactions</td>
<td>87.5%</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

Table 9. Chemistry 1 laboratory data collected from 56 Chemistry 1 students on the question “Would you like to do another animation lab?”

<table>
<thead>
<tr>
<th></th>
<th>Percentage of students who answered “Yes”</th>
<th>Percentage of students who answered “No” or were neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Reactions</td>
<td>80.0%</td>
<td>20.0%</td>
</tr>
</tbody>
</table>

Although the percentage of students who enjoyed the laboratory is lower than for Introduction to Chemistry, the data indicate that Chemistry 1 students still enjoyed this laboratory. Students gave many reasons why they enjoyed this animation laboratory. Examples are shown below.

- “I was able to show my creativity”
- “It was quick and somewhat easy”
- “It was easy”
• “I like working with PowerPoint”
• “I learned something new”

A small percentage of students, however, did not enjoy this animation laboratory and gave reasons. Examples are shown below.

• It was difficult
• Too much work on the PowerPoint
• It was stressful
• I didn’t really know how to do it
• Partner did nothing, I did all the work

Some constructive criticism that students gave to improve or modify the laboratory included doing more animations, being able to use pictures in the place of elements, performing animations that are more complex, and allowing more time for creativity. One of the main underlying themes received from students was the idea of creativity. They really enjoyed using PowerPoint and being allowed to explore on their own. They could express themselves creatively while completing the laboratory. In addition, because Chemistry 1 students are mainly 11th grade students who have established better listening skills and have greater maturity levels, they do not need to be micromanaged as much as Introduction to Chemistry students.

One major benefit of the laboratory and in-class activities was that they allowed the instructor to address, on an individual basis, misunderstandings that students had. Once students had completed the animations, they were required to show their animation to the
teacher and receive an immediate grade. This process allowed instant interpretation, immediate feedback, and correction of any misconceptions or mistakes made by the students.

**Animation Laboratory Results**

**Atomic Structure**

As part of the atomic structure animation lab, Introduction to Chemistry students were asked to choose an element and create an animation for it. The students could choose any element they wanted but were advised to choose an element with a lower atomic number for convenience. Students were also instructed to choose the most common isotope of the element. The animations were to include such components as the correct number of protons, neutrons, and electrons; the atomic mass, the mass number; and the movement of the electrons. Examples of student work that contained errors are shown in Figures 6 and 7. Figure 8 is a screen shot of an animation with no errors.
Figure 6. Screen shot of group who had a misconception in neutrons, electrons, and mass number of an animation laboratory.

**QUESTIONS**
- Protons are found in the nucleus of an atom.
- Electrons are found in the outside of the nucleus.
- The atomic number represents how many protons there are in that atom.
- The mass number represents how many electrons there are in that atom.

Figure 7. Screen shot of group who had a misconception regarding the atomic mass of an element.
An animation embedded in lecture was shown to students. This animation contained the proper number of protons, neutrons, and electrons. In addition, the proper movement of electrons was shown to students. The animation in lecture was used to show a proper example of an atom prior to students performing the animation laboratory. When the students completed the animation laboratory and were ready to submit their work, they approached the teacher for grading. Corrections were made by the teacher, and students were given the opportunity to make corrections and resubmit their work. However, the group in Figure 6 and Figure 7 failed to correct the errors in the laboratory and instead choose to turn it in “as is.” The group that generated Figure 6 and Figure 7 correctly placed protons in the nucleus and electrons circling the nucleus. They also used the correct atomic number and the correct movement of electrons. However, the students calculated an incorrect number of
electrons to represent a helium atom. Also, these students used the wrong mass number for
the atom calculated. In addition, one post-lab question was incorrectly answered. The
question was, “What does the mass number of an element represent?” The group answered
“The mass number represents how many electrons there are in that atom.” It was clear that a
misconception or wrong interpretation developed regarding protons and electrons in an atom.
However, the work of a different group shown in Figure 8 correctly determined the number
of protons, neutrons, and electrons and properly placed them in the atom.

Post-lab questions shown in Figure 7 needed more exact answers. Post-lab questions
can be viewed in Appendix D. Answers are shown below.

• Question i: Protons are found in the nucleus of the atom.
• Question ii: Electrons are found rotating around the nucleus of the atom.
• Question iii: The atomic number of an atom represents the number of
protons in the atom.
• Question iv: The mass number of an atom represents the protons plus the
neutrons of an atom.

States of Matter

Figures 9, 10, 11, and 12 contain a screen shot of an animation from a group
regarding states of matter. Figures 13 and 14 show screen shots of an animation from a
group who had incorrectly shown the motion of the atoms. The goal of this animation
laboratory was to show that solid atoms are in fixed positions and vibrate; liquid atoms are
packed tightly together, similar to solids, but free to move around; and gas atoms display no
significant attraction between them as they move in all directions. Two post-lab questions were asked to solidify understanding. One question was “Give one similarity and one difference between solids and liquids.” The other questions asked “Give one similarity and one difference between liquids and gases.” These students correctly showed the movement and position of solids, liquids and gases, properly answered the post-lab questions, and showed creativity to receive full credit for this animation laboratory.

Figure 9. Screen shot of group who properly animated the movement of solid atoms, which are packed tightly together and vibrate against each other.
Figure 10. Screen shot of group who properly animated the movement of liquid atoms, which move freely past each other but are as tightly packed together as a solid.
Figure 11. Screen shot of group who properly animated the movement of gas atoms, which move freely in all directions and show no significant attraction to each other.
1. 1 similarity between solids and liquids are that they both have a definite volume. 1 difference between them is that solids have a definite shape, and liquids take the shape of the container it is settled into.

2. 1 similarity between liquids and gases are that neither have a definite shape, they both fill their container. 1 difference is that liquids have a definite volume, and gases take up the volume and shape of their containers.

Figure 12. Screen shot of group who properly answered the post-laboratory questions.
Figure 13. Screen shot of a group who improperly showed the motion of atoms. This screen shot is before the atoms move.

Figure 14. Screen shot of a group who improperly showed the motion of atoms. This screen shot is after the atoms move.
There were several acceptable answers regarding the post-lab questions in Figure 12.

Question 1 asked students to give one similarity and one difference of solids and liquids. Acceptable answers or variations to answers include:

- Both solids and liquids have tight particle packing.
- Both solids and liquids have a definite volume.
- Solids are not compressible; however, liquids are slightly compressible.
- Liquid molecules can move freely past each other. Solids, however, vibrate together.
- Solids, unlike liquids, have a definite shape.

Question 2 asked students to give one similarity and one difference of liquids and gases. Acceptable answers or variations to answers include:

- Both liquids and gases have indefinite shape.
- Liquid particles are packed tightly together but free to move around each other in all directions. Gases, however, move fast and in all directions.
- Both liquids and gases can be compressed, but to different degrees.
- Liquids, unlike gases, have a definite volume.
- The particles in a gas move much faster than the particles in a liquid.

The group from Figure 13 and Figure 14 improperly animated the motion of the atoms in a solid. The group correctly showed the atoms vibrating in the solid; however, the atoms moved from their original place in the solid. The atoms in the solid ended up in a different place from where they started. This misunderstanding was discreetly cleared up with the students.
Classes of Chemical Reactions

Both Introduction to Chemistry and Chemistry 1 students completed an animation laboratory on Types of Chemical Reactions. Introduction to Chemistry students were required to animate single replacement and double replacement reactions. Chemistry 1 students had the option of incorporating an acid/base reaction. Students could utilize all resources including their book, notes, or sample problems. A screen shot of one group’s animations is shown below in Figure 15.

![Screen shot of one group’s animations](image)

**NaCl + FeS → NaS + FeCl**

**Figure 15.** Screen shot of a group who correctly animated but incorrectly predicted the products and did not balance a double replacement reaction.
Figure 16. Screen shot of the same group who correctly animated and predicted products and balanced a single replacement reaction.

Figure 17. Screen shot of the same group who incorrectly answered post-lab questions that classified reactions.

1. A single replacement reaction is where one element takes the place of another. \((A + BC = AC + B)\)

A double replacement is where two elements switch places. \((AB + CD = CB + AD)\)

2. The products of a combustion reaction are \(CO + H_2O\).

3a. Decomposition  
3b. Decomposition  
3c. Double Replacement  
3d. Single Replacement  
3e. Double Replacement  
3f. Single Replacement  
3g. Decomposition  
3h. Single Replacement
In Figure 15, students incorrectly predicted the products of a double replacement reaction. This mistake was discreetly cleared up with the students, and the correct products were calculated using charges on the ions. In Figure 16, the same group correctly predicted the products of a single replacement reaction. However, this could have been a coincidence. Magnesium, iron, and oxygen all contained a positive or negative 2 charge. When the double replacement reaction error was cleared up, the students then understood why their single replacement reaction worked as well. In Figure 17, students wrongly classified several of the reactions in post-lab question number 3 regarding classifying reactions. These wrong classifications were cleared up as well. The post-lab questions can be viewed in Appendix E.

Introduction to Chemistry students also performed an animation laboratory on Types of Chemical Reactions. Examples of students’ work are shown below. These students used a simpler approach to the laboratory. The students relied more on examples from homework or book problems as Introduction to Chemistry students do not incorporate charges of ions.
Figure 18. Example from Introduction to Chemistry students who incorrectly predicted the products and did not balance a single replacement reaction.
Figure 19. Example of Introduction to Chemistry students who correctly showed replacement but incorrectly predicted the chemical formulas, and did not balance a double replacement reaction.

The group who created Figure 18 developed an incorrect understanding of diatomic elements. Although the class had a basic knowledge of replacement reactions, the group misunderstood how diatomic elements were incorporated in reactions. A review of diatomic elements was discussed with the group. The group who created Figure 19 demonstrated conceptual understanding of the mechanics of the double replacement reaction, but the analysis lacked depth.

Advantages and Disadvantages of Animations

One advantage of animation in the science classroom is the ability of students to learn at their own pace. Animations allow students to learn and explore on their own. The students could access their account from any computer in the school or complete the
laboratory at home and transfer it to their account at school. In addition, students with special needs would be able to explore and learn on their own depending on their specific needs. On the other hand, gifted students could be placed in accelerated animation programs or more complex animation programs that would benefit their advanced learning style.

Utilizing animation laboratories reduced safety concerns for students. During traditional laboratories, safety is always a concern and requires the teacher to be present. This concern was eliminated as the only requirement for the laboratory was a computer. For example, some slower working students could work on it during study hall or after school in another classroom where the science teacher was not needed for safety purposes. The students would simply save the PowerPoint presentation to a flash drive or to their school account and turn it in the following day. In addition, laboratory equipment can be expensive and easily damaged. Animations can reduce the need for laboratory equipment. However, it needs to be stated that laboratory is a critical part of chemistry. Animation laboratories should be used in conjunction with traditional laboratories. Again, it is reiterated that animations laboratories are meant to supplement, but not replace, classroom and laboratory learning.

These laboratories appealed to many students because it was not only science based, but they could also exercise their creativity as well. “Although science is a creative endeavor, many students think they are not encouraged--or even allowed--to be creative in the laboratory. When students think there is only one correct way to do a lab, their creativity is inhibited” (Eyster, 2010). This laboratory allowed students to exercise their creativity by allowing the laboratory to be completed with their resourcefulness and originality. For
example, part of their grade was creativity. This allowed the more artistic students to
developed creative backgrounds and use different colors or animations while at the same
time reaching the goal of the laboratory in understanding that particular science concept.
One student stated that his favorite part of the laboratory was being able to use his own
creativity. Another student stated, “I love how you make us learn and have fun at the same
time.” These comments indicated a positive experience by the student.

During one laboratory administered to a Chemistry 1 course, students were given the
option to use symbols other than element symbols to represent elements during their
“Chemical Reactions” animation laboratory. The laboratory required students to chose two
different types of reactions and create an animation. The students were given the option to
use either elements or non-element symbols to represent their animation. Students also
needed to describe the reaction in writing as well as answer post laboratory questions to
ensure the goal of the laboratory was met. The goal of this laboratory was to build
understanding of single replacement, double replacement, combination, decomposition, and
acid/base reactions. This laboratory allowed students to expand their creativity even further
and was viewed as successful due to a strong positive response from the students. Through
discussions with students and laboratory reflections, students expressed repeatedly that they
enjoyed the laboratories. Depending on the interest of the student, non-element symbols
relating to athletics, automobiles, food, and music were used. Two examples of student
work are shown in Figure 20 and 21.
In a double replacement reaction the $2^{nd}$ and $4^{th}$ product change places. An example is shown below.

Figure 20. Screen shot of students who opted to use non-element symbols instead of elements for a double replacement reaction.
Figure 21. Screen shot of a student who opted to use both letters and symbols for a double replacement reaction.

In Figure 20 and Figure 21, the groups correctly showed each reaction keeping the proper exchange of non-element symbols. In Figure 20, the group opted to use non-element symbols to represent the reaction. However, the definition of the reaction is incorrect. The groups’ definition states “In a double replacement reaction the 2<sup>nd</sup> and 4<sup>th</sup> product change places.” This definition implies that the products of the reaction change place. The error by the group was cleared up through discussions and reiteration of the proper products of a double replacement reaction.

In Figure 21, the group properly represented a single replacement reaction. This group went above and beyond to represent the reaction using both letters and non-element
symbols. The definition of the reaction is also accurate. Also, both groups demonstrated creativity with their backgrounds as well as their choice of reactions.

The optional use of non-element symbols instead of elements for the chemical reactions laboratory was a success. Students had a positive response to the laboratory, and this laboratory was able to motivate one particular student who was very difficult to motivate. This student was quoted as saying, “This stuff is so cool.” This was encouraging from a student who has a difficult time completing other work and was clearly motivated by this laboratory. However, misconceptions could easily emerge using non-element symbols instead of elements. Also, the use of non-element symbols does not incorporate ionic charges for predicting proper product ratios. For this reason, this laboratory was only used once and was discontinued for concern of misconceptions. However, the use of non-element symbols may be a good option for a middle school or elementary school setting. The use of non-element symbols may appeal to their creativity while greater details of the reactions can be addressed in high school.

Creativity was another major benefit to animation laboratories. Creativity led to self-motivation for some students. For example, another Chemistry 1 student was very difficult to motivate throughout the year with homework, laboratories, or tests. However, he showed an instant interest in the animation laboratory involving chemical reactions and said “I had no idea all this was in PowerPoint.” This statement shows an immediate interest in the laboratory. The laboratory was able to motivate the student, which indicates a positive effect of this animation laboratory. The student completed this laboratory on time and with excellent quality. He also was observed being called on by other students for help during the
laboratory. This was encouraging to see from a student who was very difficult to motivate. This laboratory helped motivate this particular student in completing the assignment.

Another potential advantage to the use of animations is when animations are incorporated into online science courses. It may be difficult for students taking online courses to visualize an atom without teacher assistance and direction. The use of animation could greatly help these students. In addition, taking online courses can hinder a student who is an active learner. The use of laboratories in science is important, but online courses reduce active learning for the student. Traditional science laboratories are scarce with online courses, as safety becomes a large concern when doing traditional laboratories at home. Combining both animation laboratories and traditional laboratories could offer an excellent combination for online courses.

Another benefit of animation laboratories was the benefit to active learners. These laboratories required students to become actively involved in the assignment. “Anyone who has studied chemistry, or tried to teach others, knows that active students learn more than passive learners” (Bodner, 1986). By creating these animations and actively participating in laboratories, students begin to take ownership of their own education.

Sources of Error

One possible source of error was students not taking the assessments seriously. The instructor had discussions with the students to ensure they understood their role in the study. The students and their parents also signed an informed consent form informing them
of the research study and the expectations of the students. However, some students still refused to take the surveys seriously.

Another potential source of error was that there were students who refused to participate in the assessment survey or were absent the day of the assessments. Some students rarely showed up to class or simply refused to take the pre-surveys, post-surveys, laboratory reflections, or to complete the laboratory altogether. The issues of defiant or reluctant students were handled at the time they arose and dealt with in a professional manner.
Chapter 5. Conclusions

The purpose of this study was to examine the effects of animation among secondary science students on chemical concepts such as the nature of matter, atomic structure, and classes of chemical reactions. The goal of this research project was to observe the effectiveness of animation usage, which was measured through student opinions and impressions. Based on post-survey questions of lecture-embedded animations, students’ reflections of animation laboratory, and discussions with students, it is concluded that animations in the science classroom can benefit students’ motivation, promote creativity, solidify concepts, and allow students to learn at their own pace. Animation, particularly animation laboratories, offers a great way for schools to keep up with ever-changing technology. Animation laboratories assist the active learners in the classroom by offering them a cognitively active learning experience. Computer-based learning, including animations, can promote deeper levels of mental processing through cognitive processes.

Extension of this study could incorporate long-term or short-term retention of material learned through animation. In addition, more animation laboratories could be created involving bonding in chemical reactions or electrochemistry.
References


Appendices
Appendix A

Informed Consent
Research Project Title: Analysis of Animations Used in High School Chemistry Classes
Investigator: Elli Toskey, Eastern Michigan University
Co-Investigator: Larry Kolopajlo, Eastern Michigan University

Purpose of the Research:
1. To improve the chemistry knowledge and performance of high school chemistry students and improve the teaching and learning of chemistry in high school. Samples of student work for their courses will be analyzed and recommendations for improvement will be made.
2. To provide enhanced chemistry experiences for chemistry students that result in increased student learning and understanding using case studies, animations and process oriented guided inquiry learning. Such assignments must be effectively woven throughout the courses emphasizing the importance of using them as a communication and learning tool.
3. To improve the preparation of practicing K-12 teachers by implementing strong technology, writing, and inquiry-based pedagogy throughout the mathematics and science curricula.
4. Demographic data will be collected but it is not of prime importance.

Procedure for Research: Elli Toskey will explain the study to you, answer any questions you may have and this form must be returned to class. You must be enrolled in either pre-chemistry, chemistry or chemistry 2 in order to participate. This involves research that will be conducted through assignments and surveys in class. Upon completing the questionnaires, you will be given a duplicate copy of this informed consent, which includes follow-up contact information, if needed. The approximate total time to complete the questionnaires should be about 5 minutes. Each chapter covered in the course will contain roughly 2-3 surveys. There will be about 6 chapters covered during the course. The questioners will be mostly multiple choice with a few short answer questions. Some surveys will ask students to reflect on their learning of the animations.

Confidentiality: Only a code number will identify your questionnaire responses. The results will be stored separately from the consent form, which includes your name and any other identifying information. At no time will you name be associated with your responses to the questionnaires. All information will be kept in locked file cabinets of the study investigator.

Expected Risks: There are no foreseeable risks to you by completing this survey, as all results will be kept completely confidential.
**Expected Benefits:** Students will enhance their chemical knowledge and performance by using animations, case studies and heuristic writing. Students will enhance both their reflective and transactional writing skills, and hopefully use animations to improve their understanding of chemical concepts. Hopefully, participants will learn chemistry via animations, case studies and use technology as a teaching tool in science and math. The project should enhance how the teaching of high school chemistry. Faculty (University adjuncts and methods faculty) will improve their abilities to create readable math and science assignments. Samples of faculty math and science writing will be analyzed. Faculty will better understand student problems in learning chemistry and mathematics.

**Voluntary Participation:** Participation in this study is voluntary. You may choose not to participate. If you do decide to participate, you can change your mind at any time and withdraw from the study without negative consequences.

**Use of Research Results:** Results will be presented in aggregate form only. No names or individually identifying information will be revealed. Results may be presented at research meetings and conferences, in scientific publications, and as part of a master’s thesis being conducted by the principal investigator.

**Future Questions:** If you have any questions concerning your participation in this study now or in the future, you can contact the principal investigator, Elli Toskey, at (810-591-5103) or via e-mail (etoskey@bendleschools.org). You may also contact Larry Kolopajlo at (734-487-0106) or via email (lkolopajl@emich.edu). This research protocol and informed consent document has been reviewed and approved by the Eastern Michigan University Human Subjects Review Committee for use from 3/1/09 to 3/1/12. If you have questions about the approval process, please contact Dr. Deb de Laski-Smith (734-487-0042, Interim Dean of the Graduate School and Administrative Co-Chair of UHSCR, mailto:human.subjects@emich.edu).

**Consent to Participate:** I have read or had read to me all of the above information about this research study, including the research procedures, possible risks, side effects, and the likelihood of any benefit to me. The content and meaning of this information has been explained and I understand. All my questions, at this time, have been answered. I hereby consent and do voluntarily offer to follow the study requirements and take part in the study.

PRINT NAME:_______________________________________
Signature:_________________________________________
PARENT NAME:_____________________________________
Appendix B

Chemical Reactions Pre-Survey

You are invited to participate in our survey regarding classroom teaching techniques. In this survey, approximately 30 people will be asked to complete a survey that asks questions about Ms. Toskey's classroom. It will take approximately 5 minutes to complete the questionnaire.

Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point. It is very important for us to learn your opinions. Please circle your answer below

1. I have learned about density of objects
   a. Strongly Agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly Disagree

2. I feel comfortable calculating the density of an object based on mass and volume
   a. Strongly Agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly Disagree

3. I don't know the difference between homogenous and heterogeneous
   a. Strongly Agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly Disagree

4. I could give at least 2 examples of homogeneous mixtures
   a. Strongly Agree
b. Agree  
c. Neutral  
d. Disagree  
e. Strongly Disagree  

5. I know what John Dalton contributed to science  
a. Strongly Agree  
b. Agree  
c. Neutral  
d. Disagree  
e. Strongly Disagree  

6. The building blocks of matter are  
a. Mixtures  
b. Compounds  
c. Elements  
d. Properties  

7. I know what the difference between an elements and compound is  
a. Strongly Agree  
b. Agree  
c. Neutral  
d. Disagree  
e. Strongly Disagree  

8. The units for density can be (there may be more than one right answer)  
a. g/kg  
b. g/ml  
c. m/s  
d. miles/hr  
e. g/cm$^3$  

9. Working with other students could help me remember ideas about matter  
a. Strongly Agree  
b. Agree  
c. Neutral  
d. Disagree
e. Strongly Disagree

10. I understand all the different way to measure matter
   a. Strongly Agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly Disagree
Appendix C

Atomic Structure Post- Survey

Name________________

You are invited to participate in our survey regarding classroom teaching techniques. In this survey, approximately 30 people will be asked to complete a survey that asks questions about Ms. Toskey's classroom. It will take approximately 5 minutes to complete the questionnaire.

Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point. It is very important for us to learn your opinions. Please circle your answer below

1. I feel comfortable with atomic structure (protons, atomic number, atomic mass etc)
   a. Strongly Agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly Disagree

2. The animations used in the classroom help me remember the material.
   a. Strongly Agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly Disagree

3. Sample problems help me understand the material more than animations
   a. Strongly Agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly Disagree
4. Animations help me visualize an atom  
   a. Strongly Agree  
   b. Agree  
   c. Neutral  
   d. Disagree  
   e. Strongly Disagree

5. Hearing the teacher talk helps me visualize an atom  
   a. Strongly Agree  
   b. Agree  
   c. Neutral  
   d. Disagree  
   e. Strongly Disagree

6. I am ready for a test on atomic structure (protons, neutrons, atomic mass etc)  
   a. Strongly Agree  
   b. Agree  
   c. Neutral  
   d. Disagree  
   e. Strongly Disagree

7. Hearing the teacher talk helps me remember atomic structure  
   a. Strongly Agree  
   b. Agree  
   c. Neutral  
   d. Disagree  
   e. Strongly Disagree

8. Taking notes help me remember atomic structure  
   a. Strongly Agree  
   b. Agree  
   c. Neutral  
   d. Disagree  
   e. Strongly Disagree

9. Working with other students helps me remember atomic structure  
   a. Strongly Agree  
   b. Agree
c. Neutral
d. Disagree
e. Strongly Disagree

10. Animations helped me remember atomic structure
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree
Appendix D

Animation Lab
Introduction to chemistry
Atomic structure

Name_____________________
Partner_________________________

Purpose: The purpose of this lab is to build understanding of the properties of an atom.

Materials:
- Computer with Microsoft PowerPoint

Procedure:
1. Log onto a computer
2. Go to
   i. Start
   ii. Programs
   iii. Microsoft Office
   iv. Microsoft Office PowerPoint
   v. Immediately create 2-3 new slides
3. You will first create an animation representing a hydrogen atom
4. Go to
   i. Insert tab
   ii. Shape
   iii. Choose a circle. This will be the proton of the hydrogen atom.
   iv. Go to shapes again and create another circle in a different color. This is your neutron.
v. Place the proton and neutron in the center of the screen. THIS IS YOUR NUCLEUS.
vi. Create on other circle in a different color and place it outside of the circle. This is your electron.

vii. Click Animations  
viii. Custom Animations  
ix. Click on a circle  

x. Click on Add Effect (upper right hand corner)  

xi. Motion path  

xii. Draw custom path  

xiii. Scribble  

xiv. Click in the center of the sphere and while holding down the mouse, move the circle around in the box. You are creating the motion of the path of the electron. Draw large circle around the nucleus showing the path of the electron.

xv. SAVE

5. Go to the next slide  
6. Click insert and choose a circle to create one other element of YOUR CHOICE.  
7. REMEMBER, the number of protons equals the number of electrons. Place the circles in the box

8. On the last slides answer the following questions in COMPLETE sentences.
9. Questions:

i. Where are protons found in an atom?  
ii. Where are electrons found in an atom?  
iii. What does the atomic number of an atom represent?  
iv. What does the mass number of an atom represent?
10. Call the instructor over to check your animations and the answers to your questions.

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</tr>
<tr>
<td>Element 2-Correct P, N, E and placed properly</td>
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<td></td>
</tr>
<tr>
<td>Element 1-Correct movement of electrons</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Element 2-Correct movement of electrons</td>
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<td></td>
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<td>TOTAL</td>
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Appendix E

Animation Lab

Chemistry 1

Types of Reactions

Name_____________________
Partner_________________________

**Purpose:** The purpose of this lab is to build understanding of single replacement, double replacement and acid/base reactions.

**Materials:**
- Computer with Microsoft PowerPoint

**Procedure:**

1. Log onto a computer
2. Go to
   i. Start
   ii. Programs
   iii. Microsoft Office
   iv. Microsoft Office PowerPoint
   v. Immediately create 3 new slides
3. You have been shown in class how to create the animations. Your task is to chose two **different** reactions and demonstrate them using animations. There are samples in your book as well as homework assignments.
4. Your first slide needs
   i. Your name and your partners name
   ii. The date
   iii. The course
5. The second slide will contain your first reaction
6. The third slide will contain your second reaction
7. The fourth slide will answer the following questions.
8. Questions:
   1. Compare and contrast single replacement reactions and double replacement reactions.
   2. What are the products of a combustion reaction?
   3. Classify the following as
      i. Synthesis Reaction
      ii. Decomposition Reaction
      iii. Single Replacement Reaction
      iv. Double Replacement Reaction
      v. Acid/Base Reaction
      vi. Combustion Reaction
     a. $\text{Al}_2\text{O}_3 \rightarrow \text{Al} + \text{O}_2$
     b. $\text{K} + \text{Cl}_2 \rightarrow \text{KCl}$
     c. $\text{Ba(OH)}_2 + \text{HCl} \rightarrow \text{BaCl}_2 + \text{H}_2\text{O}$
     d. $\text{CaI}_2 + \text{Li} \rightarrow \text{LiI} + \text{Ca}$
     e. $\text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
     f. $\text{Mg} + \text{Fe}_2\text{O}_3 \rightarrow \text{Fe} + \text{MgO}$
     g. $\text{PbSO}_4 \rightarrow \text{PbSO}_3 + \text{O}_2$
     h. $\text{H}_2\text{O} + \text{SO}_3 \rightarrow \text{H}_2\text{SO}_4$
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Appendix F

**Animation Lab Reflection**

Name______________________________

1. Did you enjoy the animation lab? Why or why not?

2. How do you think this lab helped you with different types of reactions?

3. Did you learn anything new in PowerPoint? What new things did you learn?

4. What is the likelihood that you would do another lab similar to this?
   a. Very likely
   b. Likely
   c. Neural
   d. Unlikely
   e. Very unlikely

5. Would you like to do another animation lab? If so, do you have any ideas for another lab?

6. What would you like to see done differently in the animation lab? More animations, less animation, more complex animations, etc?