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Context Based Science Instruction

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by

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Table of Contents

Abstract

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Pedagogical approach significantly impacts student learning. Context based science instruction transforms how students think and it is more important that giving students factual knowledge. In order to be successful, students need to be active participants in their learning process; therefore science educators should place a strong emphasis on inquiry-based learning. This project is collection of context-based chemistry activities and laboratories that span a time frame of at least one semester, and show clear connections between science learned in the classroom, daily life and society. Each activity and laboratory directly link to and include New York State curriculum standards.

Chapter One: Introduction

The world views the United States as a superpower, a leader in science and technology (Kumar & Altschuld, 2004). Contemporary science education reform emphasizes the use of technology in education and it became an increasingly important area of educational research in the past few decades (Efe, 2011). Science and technology seems to be everywhere we look, changing the way we live, work, and moreover changing and escalating the problems we face in our daily life. As a nation we make decisions about problems arising from increasing human population, poverty, increasing energy demands, decreasing energy and mineral resources, pollution, global warming and so forth. Without understanding of science and technology we would not be able to make informed decisions. Science and technology aim to the above problems, and are the key to innovations. Unfortunately, according to multiple studies the United States in recent years is falling behind other countries in science and math education, and is losing the edge in science and technology (Kumar & Altschuld, 2004). According to the National Assessment of Educational Progress (NAEP), the nation's report card indicated that only eighteen percent of senior in high school achieved the scientific proficiency level (National Center for Educational Statistics, 2006).

President Obama raised alarm about the quality of science and math education in a state of the union speech and stated "Nations like China and India realize that with some changes of their own, they could compete in this new world, and so they started educating their children earlier and longer, with great emphasis on math and science. They are investing in research and new technologies" (Robelen, 2011, p.11). Despite the fact that the United States officials highly emphasized the importance of education with special attention to science and math, students in the United States perform lower than their international peers in science and math (Kumar & Altschuld, 2004; Ornstein, 2010; Robelen, 2011). This clearly demonstrates that traditional approach to science education failed us. According to Gutwill-Wise (1991), weaknesses of traditional science education are obvious, particularly when students attempt to connect science content to real world problems. There is obvious need to reform science curriculum.

Recognizing that traditional, lecture-based instructional methods were not effective, education researchers have presented arguments that science education should implicate more hands on, context-based learning. Context based science instruction is the key to success. Context based instruction can be defined in several ways. It is frequently described as context and application, a starting point for developing understanding of scientific concepts, rules and laws (Barker & Millar, 2000). Many have suggested that the Science, Technology, Society (STS) approach is a perfect example of context-based science instruction. The focus is on current issues and helps students develop a deeper understanding of science concepts while allowing students to apply skills they learn in class to daily life (Winther & Volk, 1994; Yager, 2007; Lee, 2010). According to Lee (2010), the STS approach is the driving force for scientific and technological literacy. Yager (1993) listed four key purposes of STS approach.

1) Preparing students to use science for improving their own lives and as a result to be able to better understand and cope with an increasingly technological society.

2) Enabling students as they progress through life to deal with STS issues in a responsible manner.

3) Identifying a body of knowledge that would enable them to deal with STS issues.

4) Acquiring knowledge and understanding about career opportunities in the field.

The above four key purposes of the STS listed by Yager clearly show that the STS approach closely relate science to students life, problems they may have encountered already, and encourages life-long learning and ability to use what they learn in classroom in daily life, work and society. STS provides students with real world problems, connects concepts learned in science classroom to society and daily life, allows students to practice identifying possible problems, collect data with regard to the problem, consider alternative solutions, and the consequences of a particular decision (Yager, 1990; Yager 2007). Jankins (2006) stated " it is sufficient to relate school science to what might be called 'informed citizenship' by engaging students in debates, presentations, discussions about a range of science or technology related issues likely to be of interest to the learners" (Jankins, 2006, p.207).

Suitable curriculum and teaching approach can increase scientific and technological literacy, and close achievement gap among students (Lee, 2010). The purpose of this paper is to explore and present a synthesis of research articles related to STS and context based science instruction approach in general. The impact and benefits of the context-based science instruction on student attitude and scientific literacy.

Reasons for Change

Traditional science education approaches have failed our nation and because there is a strong need to reform science education (Tytler, 2008). Arguments for change are that scientific literacy is decreasing and the achievement gap is increasing, students' attitude about science is negative, what students learn in class is disconnected from their daily life, which cause declining enrollment in science courses and decreasing interest in science related careers (Winther & Volk, 1994; Kumar & Altschuld, 2004; Jenkins, 2006). Decreasing scientific literacy, increasing achievement gap, negative attitude about science, decreasing enrolment in science courses are problems in science education. In this portion of the paper will address achievement gap and the role of pedagogical approach on overall attitude about science.

Academic achievement gaps and scientific literacy have captured the attention of multiple educational researchers. The achievement gaps in math and science between our nation's students and their peers in technology advance countries have increased over the past years (Ornstein, 2010). The data collected by National Assessment of Educational Progress in 2003, showed that eight- grade students in the United States ranked 26.5th on NAEP- PISA (Program for International Student Achievement) comparison and 15th on NAEP-TIMSS (Trends in International Mathematics and Science Study) comparison (Hambleton et. al, 2009). Furthermore, National Center for Educational Statistics reinforced persistent achievement gaps based on gender, race, ethnicity and socioeconomic status (National Center for Educational Statistics, 2005). The data collected in 2005 by National Center for Educational Statistics indicated that females have scored lower than males, Asian and white have outperformed Latinos and African American, and higher socioeconomic groups have performed better than lower socioeconomic groups. Factors such as poor facilities, pedagogical approach, limited English proficiency, socioeconomic status, gender, overcrowded classrooms, excessive absenteeism, attitude and lack of interest in the science contribute to the academic achievement gap of Latinos, African Americans and English learners. Significant inequalities in achievement remain a key challenge for teachers and schools. As schools become more diverse, teachers have to reach out to underrepresented groups of students. Staring in the early 1960s, the United States educational system and science curriculum faced multiple reforms. Half of the century passed by, billions of dollars were spent yearly on programs for low-income and low-achieving students, but achievement gaps continue to show up in grades, dropout rate, science course selection and standardized test score, the educational system in the U.S is still trapped in the state of despair (Ornstein, 2010). In order to maintain stable economy and national security, we have to increase scientific literacy and close achievement gap among students.

Pedagogical approach significantly impact student learning. An effective science education transforms how students think, more important than giving students factual knowledge, definitions and equations to memorize. Traditional science instruction which include lecture, cookbook laboratories, note taking and memorization of factual knowledge are the primary modes of instruction used in schools around the world (Lee & Erdogan, 2007; Wu & Huang, 2007, Tytler, 2008). Yager (2007) claims that traditional science curriculum does not leave any room for creativity. The teacher is at the center of the learning process controlling what the students learn and how they learn it (Wu & Huang, 2007). Data show that traditional approaches to teaching science are not successful for a large proportion of our students. The effectiveness of traditional teaching or distribution of information from teacher to the student has failed, and has frequently come under analysis of multiple educational researchers (Biggs, 1996; Wu & Huang, 2007). Traditional science laboratories that resemble cookbook recipes very common in schools are perfect example of passive learning, very little or none is learn from them (Lord & Orkwieszewski, 2006). Textbook approach and cookbook laboratories reduce students natural curiosity, motivation, creativity, and contribute in the development of negative attitude toward science, because they totally disregard students' interests (Lee & Erdogan, 2007) In order to be successful, students need to be active participants in the learning process. Lord & Orkwieszewski (2006) explained that students need to experience context based leaning, otherwise they will mentally tune out and passively wait for the bell to ring.

Chapter Two: Review of literature

Context-Based Science Instruction

National Science Education Standards stress the importance of teaching science through context-based instruction (National Research Council, 1996; National Research Council, 2000). Deviating from the traditional mode of instruction, context based science instruction highlights a change in the instructional pattern (Stuart & Henry, 2002). Context based science is student center, and encourages student learning through observation, connection and authentic instead of factual memorization. Context-based approach allows students to develop a richer and deeper understanding of the concepts they are learning (Smolleck & Yoder, 2006). Context based science approach is very valuable; it gives students practice in defining problems, gathering data to solve the problems, and helps develop higher-order thinking skills. Multiple studies verified the benefits of context based science education. Context based learning crafts an atmosphere in which students actively participate in the learning process, take charge of their own learning, learn time management skills, improves critical thinking, problem solving, communication, collaboration, interpersonal skills, and students' interest in science (Sungur & Tekkaya, 2006). Context based laboratories or class activities significantly improve students' learning process (Yager, 2007; Lord & Orkwieszewski, 2006). Context based learning goes beyond the step-by-step laboratory or science instruction, it promotes higher order thinking, increase attitude about science, creativity and fuels understanding, students on their own identify problem, design procedures, arise with control and variables, articulate conclusion and possible outcome and solution to the problem (Lord & Orkwieszewski, 2006; Lee & Erdogan, 2007).

Sungar and Tekkaya (2006) study compared effects of context based learning and traditional instruction on self-regulated learning. The study population included two groups of ten-grade students within the same high school, enrolled in the same biology course with the same teacher. The control classroom was taught in traditional teacher-centered and textbook-oriented approach, which included teacher explanation, the use of textbooks, and worksheets. In contrast, the experimental classroom was taught using a problem-based learning approach, which incorporated a mix of resources, independent study, and group discussion to address case studies. The results suggest that those taught using the problem-based learning approach had higher self-regulation measures, increased interest in science, critical thinking and problem solving.

Yager (2007) claimed that in order for the context based/STS educations to be successful, teachers have to change their approach and act differently, "students have to be center of the classroom, the activities planned, and data collected…" (Yager, 2007, p. 386). Science teacher believes and values must be harmonious with the principle of responsible citizens in order to successful implement the STS teaching approach into practice (Rubba, 1991). Due to values and believes great number of pre-service and in-service teachers failed to implement inquiry into practice (Rubba, 1991). For example, according to Montes and Rockly (2002) only 15 percent of science teachers' grade 8- 12 have tried inquiry in their class, furthermore only 5 percent of those teachers incorporated more than one inquiry based activity per semester.

Improving Science Learning and Instruction Through Context Based Instruction

It has been proven that students learn best by doing, and exploring science concepts. "Tell me and I'll forget; show me and I may remember; involve me and I'll understand". According to Gerber al. et. (2001), exploration, term introduction, and concept application are three key components that allow students to learn science (Gerber al. et., 2001). In exploration, students participate in labs and activities that permit them to their test ideas, conduct experiments, and collect data. Term introduction increases student understanding of key concepts, allowing students to better understand and employ collected data. Concept application, move students up on Bloom's Taxonomy Pyramid, requires students to use data to draw conclusions or apply concept learn in new learning situations. The STS approach allows all three components to occur at the same time it allows students to learn and enjoy science more (Gerber al. et., 2001).

Ratcliffe (1999) conducted a study to explore understanding of the nature and use of scientific evidence using media reports, and to compare understanding among different age groups. The study population included mix age and sex groups, group of school students 11-14 years old, group of 17 years old college students enrolled in science course and group of graduate science students 22-35 years old. Each group read article and completed questioner. The school students (11- 14) read the article as a class, volunteers each reading a paragraph or so, with the class teacher assisting with difficult words. The teacher then asked the class to compete the questions by themselves, it require a re-reading of the article. As expected, the report indicated that the skills increase with formal training, experience, and self- selection into science, Ratcliffe noticed that the skills of evidence evaluation a component of functional science were evident across all age group. Ratcliffe implied that the abilities could be developed more with explicit teaching method (Ratcliffe, 1999).

Yager et.al (2009) preformed semester long action research to compare learning among middle school students taught with STS versus textbook based instruction. 15, 4th, 5th, 6th teachers participated in the study. All of the 15 teachers prior to the study completed Iowa Chautauqua Workshop and have helped other teachers implement STS. The Chautuaqua model was design to improve science teaching and learning in six domains: concepts, processes, application, creativity, attitude and Worldview (Yager, 2009). The six domain addressed in Yager al. et. (2009) study were measure. To measure the learning of concept domain teacher developed pre and post-test. To measure process domain common test was used (did not specify what common test). Attitude was measured at the end of semester with 30-item survey, creativity was measure based on "discrepant event" during the semester. Based on the use of contents in new situation the domain of application was measured. The Views on Science-Technology Society were used to measure Worldviews. Result of posttest comparison of 4th grade students in STS and non-STS, show that STS students differed significantly from non-STS students in five out of the six domain. STS students' average scores were double the average scores of non-STS students in process, application, creativity, and attitude domain. The Worldview domain shows largest gap between these two groups, the average score of STS students was 48.3 and 13.61 for non-STS students. The STS students' average score in the concept domain was 11.34, which is still 0.72 higher than the average score of non-STS students. The posttest scores for 5th grade students were comparable to posttest scores of 4th grade students, with one exception 5thgrade non-STS students score 0.35 higher in concept domain then 5th grade STS students. 6th grade STS students score preformed higher than non-STS students in all domains except concept, the difference however was insignificant (0.08). The data gathered in the study clearly show that there is no difference in the concept acquisition with neither of the teaching approaches. However, STS students outperformed the traditional-textbook based non-STS significantly in process skills, creativity, application, attitude and Worldview. As the results of the study indicate that STS students did not yield neither better nor worst achievement in the Concept domain, the STS students outperform non-STS students in the other five domains, I question reliability and validity of the research. First, since each teacher was teaching both STS and non-STS course, were they able to stay fair-minded, or were they more supportive of STS. Second, the assessment methods in this study are inconsistent, especially in domains of creativity and Worldview.

In the past two decades the STS approaches to teaching science have become commonly used across the nation. Number of teachers and professionals involved in curriculum development recognize the benefits associated with the STS approach, pointing out STS that it successfully aims toward achieving scientific and technological literacy for all students (Akcay & Yager, 2010).

Akcay and Yager (2010) conducted a study to examine the impact of STS teaching approach on students learning in five domains: concept mastering, process domain, creativity domain, attitude domain and application domain. Total of 12 teachers and 724 students grades six through nine participated in the study. The students were split into two groups student center STS approach and teacher center STS approach in order to evaluate the effect of student center STS approach. The results of the study show that there was no difference in mastery of basic science concepts, however the in student center STS instruction achieved much higher than students in teacher center STS instruction in terms of understanding and use of science process skills, creativity skills, developed more positive attitude about science, and were able to apply skills learned in class to new situation (Akcay &Yager, 2010).

Technology in Science and Society

Being tech savvy is a form of social capital. There are many ways that technology can benefit students education, it can support, accelerate, enrich and increase basic skills. Multimedia presentation and simulation software such as Interactive Physics or Agent Sheets provided teachers the chance to present abstract topic that may not be possible otherwise.

According to Metcalf and Tinker (2004) technology in the classroom, particularly computer models and simulations, supports and improve learning of science standards difficult to teach without the access to technology. The researchers conducted a study that implemented technology to teach topics related to physical science to students in grade six through eight. Prior to implementing the technology-enhance instruction participating teachers were provided with professional development. Findings based upon pre and post-tests score indicated gains for all groups except two groups of eighth grade students. These two groups of eight grade students exhibit a two percent decline in scores on the post-test. The pre and post test data of the other groups in the study showed significant improvement, the highest improvement reached 19 percent, and occurred when students were able to spend more time using the probe ware. The study specified lower improvements were seen when the probe ware was used in rush, or when students scored high on the pretest, which suggested that students master the content already. All students from the study were surveyed in order to collect qualitative data on student attitudes toward the technology in science class. The survey evaluation indicated that the technology made learning more interesting and enjoyable for students. The founding of the study clearly showed that student achievement and learning was significantly enhanced by the use of technology (Metcalf & Tinker, 2004).

The applications of technology in science education capture the attention of multiple educational researchers in past decades (Efe, 2011). Technology significantly contributes to science teaching and learning, by moving from teacher-center to student-center learning (Efe, 2011). Beak et al. (2008) Research based evidence show that older and more experienced teachers are unwilling to implement educational technology in to their classroom. Newly qualify teachers and students teachers, on the other hand, are more open to education technology (Efe, 2011). Obstacles such as lack of training, lack of time, software, hardware, keyboarding skills, knowledge of available information technology resources, poor technical support, unavailability of computer labs, and personal believes prevent teachers from implementing use of technology into their classroom (Beak et al, 2008). Teachers' willingness and attitude are the keys to successful use of educational technology (Efe, 2011).

Science Technology and Society Approach to Science Instruction

STS, and context based instruction in general has been the major focus of educational research in past decades. STS approach to science education was created to increase students' scientific literacy and decision-making skills regarding socially relevant science issues. Though STS is not a modern idea, as STS education becomes more and more popular, countries around the World emphasize the benefits of STS instructional philosophy (Solomon & Aikenhead, 1994). According to DeBoer (1991), starting in 1950 science educators alarmed the need to teach socially relevant science. Jerkins (2006) showed that current efforts to engage school science with citizenship are not new, in fact according to him it goes back to mid-nineteenth century England. In the early 1980s the Blue-Ribbon Policy Group examined the statue of school science education in the United States (Rubba, 1991). As the results showed low level of scientific and technology literacy among students, they suggested implementing STS into K-12 science curriculum to increase scientific and technology literacy, and to prepare students to deal directly with STS Issues (Rubba, 1991). Stating " our best hope for the resolution of STS related issues are citizens literate in science and technology, and empowered to make informed decision and take responsible actions" (Rubba, 1991).

Over time the name "STS" fluctuates from country to country. As of today research shows numerous of STS education approaches to science curricula: "Socioscientific Issues" (Klosterman & Sadler, 2010), "Science-Technology-Society-Environment" (Dori & Tal, 2000), " Citizen Science" (Jenkins, 1999), "functional scientific literacy" (Ryder, 2001), "science for public understanding" (Osborne et al., 2003), "problem or project based learning" and "inquiry-based science education" (Lee & Erdogan, 2007).

Multiple studies suggest that the context-based approach to science education has great potential to increase scientific and technological literacy (Winther &Volk, 1994; Klosterman & Sadler 2010; Lee, 2010). Lee (2010) in his article affirmed that, " there is a strong tendency to view STS as a vehicle for scientific and technological literacy" (Lee, 2010). The National Science Standards and the Benchmarks for Science Literacy also support and encourage the STS approach to science education (NRC, 1996; AAAS, 1993, Kumar & Altschuld, 2004). The STS approach does not set a precise way of teaching, is center around the interactions between science, technology and society, defines general goals and advocates that teaching should be meaningful, engaging and appropriate for all students (Lee & Erdogan, 2007). STS education offers major advantage over traditional teacher centered approach. Analyses of multiple educational researches (Yager, 1993; Lyons, 2006) have implied that most students expressed positive attitudes on the importance of scientific and technological issues to society but also that there is need to implement new strategy for increasing students interest and knowledge in science and their ability to use science learned in class in their everyday life. Research has proved that the above problems could be address and solve with the STS education.

According to National Science Teacher Association (2007), the STS help to reach scientific literacy for all. Roy (2000) explained that the STS helps students increases understanding of science and technology issues, points out the impact of technology on their life and shows career opportunities for future (Roy, 2000). The STS approach becomes one of the current targets for science education. STS approach unlike traditional curriculum places emphasis on the connection between science, technology and society and is expected to raise scientific and technological literacy, interest and understanding of science among students.

STS in Support of Scientific Literacy

Scientific literacy has been the focus of multiple education research. According to Hodson (2010), Paul Hurd first introduced the term scientific literacy back in 1958 (Hodson, 2010). There is no single definition of scientific literacy, yet work of De Boer (2000) listed nine conceptions of scientific literacy that were popular at different points in history.

1) Teaching and learning about science as a cultural force in the modern world.

2) Preparing for the world of work.

3) Teaching/learning science that have direct application to everyday living.

4) Teaching students to be inform citizens.

5) Learning about science as a particular way of examining the natural world,

6) Understanding reports and discussion of science that appear in the popular media.

7) Learning about science for its aesthetic appeal.

8) Preparing citizens who are sympathetic to science.

9) Understanding the nature and importance of technology and relationship between technology and science.

Science education has undergone a period of reform in the past century. The main goal of science education reform is to promote scientific literacy among all students. Science for All Americans (American Association for the Advancement of Science, 1992) articulates that since science in an integral part of living, all students must become scientifically literate and learn basic elements of science in order to become productive citizens. Winther and Volk (1994) indicated that failure to conquer scientific literacy could stop students from full responsibility as citizens and full participation in nation economics. Science education reform sets clear expectation that all students before, high school graduation, need to achieving science literacy. Unfortunately, in the last four decades common misconceptions of basic scientific concepts among students have been documented, proving that achieving scientific literacy is not easy task (Baker, 2004). Roy (2000), for example claims that STS approach to science education increases students understanding about current issues related to science and technology, raises scientific literacy and awareness of the impact that science and technology play in daily life (Roy, 2000). Based on multiple research it is clear that STS is a key to scientific literacy, unfortunately many teachers still continue to teach science in traditional way, therefore what students learn in the science classroom is disconnected from their daily lives (National Research Council, 2000).

Real Example of Context-Based Science Curriculum: ChemCom-Background

The declining enrollment, difficulty and negative attitude that students demonstrate in chemistry classes have been well documented in last couple decades (Winther& Volk, 1994). According to Gutwill-Wise (2001), since chemistry curriculum failed to serve students effectively, reform in chemistry curriculum has been well acknowledge and necessary. Research show that context based curriculum aim to increase the significance of chemistry by developing chemistry concepts within authentic application of chemistry concepts in technology and society (Winther& Volk, 1994).

ChemCom course developed by American Chemical Association in the early 1980s was organized around STS approach. Traditional high school science courses do not address the relationship between science, technology and society. Since traditional chemistry courses were based on memorization of factual knowledge and cookbook laboratories, there is a need for chemistry course that would change students attitude about science, motivate students to learn more science and recognize the value of science in daily life and society (Sutman& Bruce, 1992). Research based evidence show that students enrolled in context based science courses, such as ChemCom realized the connection between chemistry and their life and appeared to enjoy the course more

(Gutwill-Wise, 2001). The ChemCom course curriculum focuses on topics that the students face in their daily life. Traditional chemistry courses were not engaging, did not spark students interest in science and did not prepared students to act like/as productive citizens (Nelson, 1988; Winther& Volk, 1995). According to Nelson (1988), ChemCom was designed for high school students captivated by significant and usefulness of chemical phenomena (Nelson, 1988). The ChemCom was not design to be water down science course, but to present an intellectually challenging alternative to traditional chemistry course.

According to Mason (1996) students enrolled in ChemCom chemistry course in high school achieved the same marks as students who completed traditional chemistry course, when enrolled in a first year university chemistry for non-majors. ChemCom curriculum helps students develop understanding of chemistry, promote problem solving and critical thinking skills related to chemistry, acknowledge the importance of chemistry in daily life, and apply chemistry knowledge to decision making about science and technology issues (Chemistry in community, ChemCom 5th edition). ChemCom is a whole yearlong course organized around seven units, which introduce students to community issues related to chemistry and science:

1) Water: Exploring Solutions. Physical and chemical properties, formulas and equations, ions, solutions.

2) Materials: Structure and Use. Properties, periodicity, atomic structure, the mole.

3) Petroleum: Breaking and Making Bonds. Bonding, nomenclature, organic chemistry.

4) Air: Chemistry and the Atmosphere. Gas laws, acid-base chemistry, kinetic molecular theory, green chemistry.

5) Industry: Applying Chemical Reactions. Oxidation-reduction, kinetics, equilibrium, industrial chemistry, environmental chemistry.

6) Atom: Nuclear Interactions. Atomic structure, nuclear radiation, nuclear energy.

7) Food: Matter and Energy for Life. Biochemistry, energy relationships, organic chemistry.

ChemCom presents chemistry on need to know basis, analyze and connect chemical principals to community issues (Chemistry in community, ChemCom 5th edition). ChemCom just like traditional curriculum cover major concepts, principles and laboratory skills, but include more organic and nuclear chemistry, less math and physical chemistry (Sutman& Bruce, 1992). This is very beneficial for students who feel intimidated by math, and science courses such as chemistry or physics, because they require strong math background. Major advantage of ChemCom over traditional chemistry course is the fact that ChemCom allow students to make decision, it allows students to select problem of their interest and propose a solution to the problem, which promotes higher order thinking (Nelson, 1988).

Sutman and Bruce (1992) wrote evaluation report of ChemCom, conducted during its development and field-testing stage (Sutman& Bruce, 1992). The report clearly shows that ChemCom is a valid, highly functional instructional program. Students enrolled in ChemCom course score higher then students enrolled in traditional chemistry course (Sutman&Bruce, 1992). Sutman and Bruce (1992) stated that ChemCom motivates students to pursue the next level of advanced study in chemistry much more than traditional chemistry courses.

ChemCom in Action

In order to increase scientific literacy, we have to address and focus on the minority students, African-American and Hispanic. According to Winther and Volk (1994) by the year of 2010, 38 percent of students will be minority, 48 percent by 2020. Winther and Volk (1994) compared achievement of inner city high school students in traditional versus STS ChemCom based chemistry class. Winther and Volk conducted a study that implanted ChemCom, STS based science curriculum into urban school position in the middle of African-American neighborhood. All students in this study were average ability African- American, enrolled in ten, eleven and twelve grade. Most of them would never have taken chemistry if they attended different school. Total of eight chemistry classes and two teachers participated in the study, four classes in control group used traditional textbook based chemistry curriculum and the remaining four used ChemCom curriculum. The finding of the study indicated that African-American students enrolled in ChemCom scored higher on standardized chemistry measure than students enrolled in traditional course (Winther & Volk, 1994). The study point out that STS based teaching is a great alternative for effective science education. The authors said " Chemcom should be view as one tool that can be used to prepare a much larger and more representative group of scientifically literate citizens than we have in past (Winther and Volk, p 505).

Smith and Bitner investigated the effect of ChemCom versus traditional Chemistry on the acquisition of logical thinking skills and any possible difference in reasoning levels students in the two groups might have (Smith &Bitner, 1993). The students in traditional chemistry were enrolled in courses taught as pre requisite for students pursuing science related degrees and careers. Among the pre requisite, the students had to have passed Algebra 1 with grade of 75 percent or be higher. The students in ChemCom were pursuing careers not related to science. ChemCom course did not require math. The founding of this study indicated that ChemCom Students showed a large gain in six reasoning skills then students enrolled in traditional chemistry class (Smith & Bitner, 1993).

Chapter 3: Application

This project is designed to be a collection of context-based chemistry activities and laboratories that span a time frame of at least one semester, and show clear connections between science learned in the classroom, daily life and society. Each activity and laboratory directly link to and include New York State Chemistry curriculum standards. There are many instances where this collection of laboratories and activities will be very useful to chemistry teachers. The main benefits of context based laboratories and activities are greater interest in particular aspects curriculum, connection to students' everyday life and increased motivation. Additional instances where context-based laboratories and activities are particularly useful include, but are not limited to:

- Engage students in responsible personal action, after weighing the possible results of alternative options.
- Apply curiosity, logical reasoning, and creativity in investigating the observable physical phenomena.
- Identify problems with local interest and impact.
- Use local resources to locate information that can be used in problem resolution.
- Allow teaching to go beyond a given class session.
- Allow students to perform as active citizens as they attempt to resolve issues they indicated.
- Allow students to focus on career awareness.

The intent is for this collection to show that context-based laboratories and activities offer a great alternative to many traditional laboratories and activities. While the intent is not to completely replace traditional chemistry laboratories or activities, the goal of this project is to help students make a clear connection between the science classroom, everyday life, technology and society.

Isomers- Thalidomide tragedy

Objectives:

Students will be able to:

- Understand that isomers have same molecular formula, but different structures and properties.
- Distinguish between the two main categories of isomers, structural and stereoisomers.
- Describe the conditions under which geometric isomers are possible.
- Identify and describe optical isomers.

NY State Standard:

Chemistry St. 4, 3.1ii: Isomers of organic compound have the same molecular formula, but different structures and properties.

Materials:

Molecular kits, laptops with Internet access, chemistry reference book

Procedures

Initiating:

1. Begin class with question: Have you heard of drug called thalidomide*?* Explain that in the late 1950s and early1960s Thalidomide was prescribe to pregnant woman to ease their morning sickness.

2. Next project a video about Thalidomide victims.

Link: http://www.youtube.com/watch?v=-G7UKLczVaU&feature=related

3. Lead class discussion about the side effect of Thalidomide. (Point out that many patients that used Thalidomide had severe birth defects, while others none at all). Explain

that closer examination on the chemistry of Thalidomide showed that is existed as two isomers. One isomer was the mirror image of the other but only one of the two optical isomers of Thalidomide appeared to cause these birth defects. The R-isomer was responsible for relieving morning sickness while the S-isomer caused birth defects.

4. Point out to students that in this lesson, we study different configurations of hydrocarbons that have the same number of hydrogen and carbon atoms. The different arrangements of these molecules are called isomers.

- Distinguish between the two main categories of isomers (structural isomers and stereoisomers).
- Explain that structural isomers have different physical and chemical properties despite having the same formula.
- Explain how to differentiate between geometric cis- and trans- isomers.
- Describe the structural variation in molecules that results in optical isomers.

Transacting:

1. Pass out models of three alkanes (pentane, 2-methylbutane, 2, 2-Dimethylpropane) and have students examine how they are different.
2. Ask students to draw structural formula for heptane C_7H_{16}. Then have students make all structural isomers of heptane name and draw each one in their lab notebooks.
3. Pass out chemistry reference books and ask students to find and record the boiling and melting point of each the isomers.

Applying and exploring:

As you learn in the beginning of the class, enantiomers are optical isomers that are non-superimposable mirror image structures. The property of non-superimposable isomers is called chirality. Chirality of drug is a critically important issue in drug development. Almost 60% of the drugs used clinically are chiral compounds. But only few of them have been studied as different isomers, most of these drugs are studied as racemates. The thalidomide tragedy forced drug companies to reconsider enantiomers as separate molecules rather than just different forms of the same drug, pharmaceutical companies investigate the properties of each enantiomer of a new chiral drug before they introduce it to the market. Your task is to research drug design and answer the following questions.

1. Why is drug chirality important?
2. Explain what caused the thalidomide tragedy?
3. Why has thalidomide been approved for sale again?
4. Why is thalidomide chiral?
5. A drug has two isomers. Why might the drug manufacturer try to produce a medicine consisting of only one of the two isomers?
6. Why are drug molecules often chiral in order to have positive effects in humans?
7. What should drug companies consider when they develop and market new chiral drugs?

Assessment:

Use students respond to questions 1-7 from applying and exploring section.

Implementation recommendation:

This lesson is great addition to unit on organic chemistry.

Vitamins in our Diet

Objectives:

Students will:

1. Explore solution stoichiometry and analysis.
2. Gain understanding of how oxidizing agents react with reducing agents.
3. Measure how different substances react to the presence of iodine.
4. Predict which beverage contains most vitamin C
5. Draw conclusion about the nutritional value of different beverages.

NY State Standards

Chemistry St. 4, 3.3c: A balanced chemical equation represents conservation of atoms. The coefficients in a balanced chemical equation can be used to determine mole ratios in the reaction.

Chemistry St. 4, 3.3f: The percent composition by mass of each element in a compound can be calculated mathematically.

Materials:

Apple Juice, freshly squeeze orange juice, Tropicana orange juice, cranberry juice, starch solution, iodine solution, vitamin C solution, 125-mL Erlenmeyer flask, buret clamped into ring stand

Procedures

Initiating:

Lead class discussion about vitamins. Explain that the importance of vitamins has been recognized for over 200 years. The human body needs vitamins, minerals and elements in small amounts to facilitate normal metabolic reaction and to maintaining good health.

Lack of vitamins, minerals and elements can lead to abnormalities in growth, development and the functioning of body's cells. For examples: potassium is needed for proper nerve function, muscle control, and blood pressure. A diet low in potassium and high in sodium might be factor in high blood pressure. Vitamin D promotes calcium absorption and is needed for bone growth and bone remodeling by osteoblasts and osteoclasts. Without vitamin D, bones can become thin, weak, or misshapen. Together with calcium, vitamin D also helps protect from osteoporosis. Phosphorus is essential element in living systems, phosphate groups occur regularly in DNA strands. Without vitamin B-12, body is unable to synthesis DNA properly, which effect the production of red blood cells. Vitamin C is an essential component of the diet for humans. A deficiency of vitamin C leads to a disease known as scurvy, characterized by hemorrhages throughout the body, which are especially noticeable on the gums and around the mouth and other areas of the skin with abundant vascularization (blood vessels). It is an essential cofactor in the synthesis of the protein collagen, which connects cells in the body, especially in the blood vessels.

Have students' brain storm a list of foods that are good source of vitamin C.

Transacting:

In this laboratory you will measure the amount of vitamin C in various beverages. Vitamin C is detected by its ease of oxidation. When vitamin C is oxidized by iodine, the free iodine shows itself by turning starch solution blue-black.

1. Which beverage sample do you think has the most vitamin C? Which to you think has the least? Rank your beverage samples according to your predictions?
2. Fill buret with iodine solution.

3. Measure 25 mL of vitamin C solution into a 125-mL Erlenmeyer flask, and add 10 drops of starch solution.
4. Slowly add iodine solution to the flask until one drop of iodine solution cause the vitamin C solution to turn blue- black. Record the volume of iodine solution used, and fill in the data table. A piece of white paper placed under the flask will help you recognize the color.
5. Repeat step 4 with apple juice.
6. Repeat step 4 with fresh squeeze orange juice.
7. Repeat step 4 with Tropicana orange juice.
8. Repeat step 4 with cranberry juice.

Data Table

Test Sample	**mL of Iodine**	**mg of Vitamin C**	**Predicted Rank**	**Actual Rank**
Vitamin C solution				
Apple juice				
Freshly squeeze orange juice				
Tropicana Orange juice				
Cranberry juice				

Questions:

1. How does the amount of iodine solution used indicate the vitamin C content?
2. Based on the titrations you did, what beverage had the highest vitamin C content and which one had the lowest?
3. Among the beverages tested, were any vitamin C levels

a. Unexpectedly low, in your opinion? If so, explain.

b. Unexpectedly high, in your opinion? If so, explain.

4. What other common foods contain a high level of vitamin C?

Applying and exploring:

Have students answer the following questions:

1. The recommended daily allowance, RDA, of vitamin C is 60 mg. What percent of your US RDA for vitamin C is contained in one 8-oz serving of each of the beverages tested?
2. Food labels often say to refrigerate after opening. Design experiment to find out if the content of vitamin C changes over time at different temperatures and predict answers to the following situations. Explain your answers.
    a. What if orange juice were left uncovered in a glass for some time? Would this change the vitamin C content of the juice?
    b. What if some orange juice were kept in a sealed container, but not kept refrigerated? Would this change the vitamin C content of the juice? Does it matter how long it is left out of the refrigerator?
    c. What if the orange juice got frozen? Would this change the vitamin C content of the juice?

Assessment:

To assess students understanding collect lab reports and answers to questions in applying and exploring section.

Implementation recommendation:

Implement this lesson into unit on stoichiometry.

Salting an icy sidewalk

Objectives:

Students will be able to describe phase change, solubility, and freezing point depression.

NY State Standard:

Chemistry St. 4, 3.1qq: The addition of a nonvolatile solute to a solvent causes the boiling point of the solvent to increase and the freezing point of the solvent to decrease. The greater the concentration of solute particles, the greater the effect.

Chemistry St. 4, 3.2a: A physical change results in the rearrangement of existing particles in a substance. A chemical change results in the formation of different substances with changed properties.

Materials:

4 large beakers, ice, thermometers, popsicles, timer, Excel, cotton string, pencil, salt

Procedures

Initiating:

1. Discussion: In the winter, when ice form on sidewalks and roads salt (sodium chloride or calcium chloride) is sprinkled on the ice, it is a low cost and effective way to remove ice from pavement. Salt causes the ice to melt, as its surface becomes a salt solution, and it will not freeze unless the temperature drops, below its new freezing temperature. Today we will learn the science behind this chemical principle.
2. Demonstration: Tie one end of cotton string to the pencil and wet the other end of the string. Put the wet end of the string on the ice cube and sprinkle some salt over the ice cube. After about 20 seconds the string will freeze to the surface of the ice

and you can lift it up.

3. Ask students, why would the string stick to ice, if the salt lowers the freezing point and the ice melts?
4. Also, identify characteristics of substances, distinguish between physical and chemical properties and differentiate among the physical state of matter.

Transacting:

1. Take the two large beaker 500 ml and fill them with equal amounts of ice, about 2/3 full. Label the beakers A, B, C and D.
2. Make a prediction about what will happen to the temperature when we add salt to the beaker.
3. Share predictions with the class.
4. Place an unfrozen freeze pop in each of the beakers so that it is surrounded by ice.
5. Place a thermometer in each beaker and record the temperature of the ice.
6. Mix one cup of salt (sodium chloride) with the ice in beaker A, cup of calcium chloride salt with the ice in beaker B and cup of magnesium sulfate salt with ice in beaker C.
7. Record the temperatures in each of the beakers every five minutes in a table.
8. Add another 1/2 cup of salt into beaker A, B, and C at 15 and 25 minutes into the experiment.
9. Continue taking temperature readings for 30 minutes and record their findings in the table.
10. Observe the freeze popsicles at the end of the experiment, and determine which one has frozen and its degree of hardness. Record the results and observations.

11. Graphs in Excel results for beakers A, B, C and D.

Applying and Expanding:

Answer the following question

1. What happened to the temperature of the beaker A, B and C?
2. Was your prediction correct?
3. Why did the temperature change in beaker A, B and C?
4. Why did the salt-ice mixture produce a lower temperature than the ice with no salt added?
5. Which salt is most effective?
6. Why do we sprinkle calcium chloride instead of sodium chloride salt on icy roads?

Assessment opportunities:

Assess students understanding based on class discussion and answer to questions 1-6 from applying and exploring section of the lesson.

Implementation recommendation:

This activity can be easily implemented to teach changes and properties of matter.

Periodic Table

Objective:

Students will be able to:

- Read the periodic table.
- Describe the organization of periodic table.
- Explain the properties of elements based on their placement within the periodic table.

NY State Standards:

Chemistry St 4, 3.1u: Elements are substances that are composed of atoms that have the same atomic number. Elements cannot be broken down by chemical change.

Chemistry St 4, 3.1v: Elements can be classified by their properties and located on the Periodic Table as metals, nonmetals, metalloids (B, Si, Ge, As, Sb, Te), and noble gases.

Chemistry St 4, 3.1w: Elements can be differentiated by physical properties. Physical properties of sub- stances, such as density, conductivity, malleability, solubility, and hardness, differ among elements.

Chemistry St 4, 3.1x: Elements can also be differentiated by chemical properties. Chemical properties describe how an element behaves during a chemical reaction.

Chemistry St 4, 3.1y: The placement or location of an element on the Periodic Table gives an indication of the physical and chemical properties of that element. The elements on the Periodic Table are arranged in order of increasing atomic number.

Chemistry St 4, 3.1z: For Groups 1, 2, and 13-18 on the Periodic Table, elements within the same group have the same number of valence electrons (helium is an exception) and therefore similar chemical properties.

Chemistry St 4, 3.1aa: The succession of elements within the same group demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.

Chemistry St 4, 3.1bb: The succession of elements across the same period demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.

Materials:

Mystery boxes (box filled with verity of objects), periodic tables, computer chips, Laptops with Internet access.

Procedures

Initiating:

1. Open the lesson by asking students to practice a classification activity. Pass out mystery boxes, one per group. Ask students to find common patterns among the various characteristics of the objects in the mystery box, and then ask them to arrange all objects in one "grand scheme." Their classification scheme should recognize relationships among different characteristics, like mass, color, texture, or size.
2. Have students compare their classification with other groups.
3. Pass out periodic tables.
4. Transition to a discussion of the process through which science has classified elements:
   - Discuss contribution of Dobereiner, Newlands, Mendeleev, and Moseley made to the periodic table.
   - Describe the organization of periodic table.

- Identify groups within periodic table.
- Explain why elements in a group have similar properties.
- Identify four important periodic trends and explain how each reflects the election configuration of element.

Transacting:

1. Pass out computer Chips and start class discussion about properties and application of computer chips.
2. Play you tube video,

Link: **http://www.youtube.com/watch?v=GursOom9dNA**

3. Have the students research background information on the topic and have a debate on the issues surrounding the procedure.
4. Have the students reflect upon the technological, medical, societal and personal implementation as they prepare their argument.
5. Have the students write a report of their argument and summery of the in class debate.

Applying and expanding

1. Numerous steps are needed to create one computer chip. Research how computer chips are made.
2. In a paragraph or two explain why Silicon is an ideal material for the production of computer chips.

Assessment:

To assess understanding ask students to:

1. Briefly explain arrangement of elements in periodic table, name the four periodic trends and describe how each trend reflects the elements' electron configuration.
2. Apply you knowledge about periodical trends to explain the scenario. A piece of sodium metal reacts with chlorine gas to form sodium chloride, table salt. Explain why elemental sodium and chloride react so rapidly. Would you expect any energy to be released in this reaction? Explain you answer.

Implementation recommendation:

Implement this this lesson into unit on the periodic table and periodic law.

Groups of Elements- Lead Poisoning

Objectives:

After completing this lesson students will be able to:

- Describe the organization of the periodic table
- Identify the groups within the periodic table and state what properties elements have in common and why.
- Develop knowledge about potential sources of lead exposure.
- Understand why lead poisoning is a serious health threat.
- Understand the potential health effects of lead poisoning.
- Learn about the primary routes of exposure to lead.
- Identify a few potential signs of lead poisoning.
- Be able to implement strategies and actions to reduce or eliminate exposure to lead

NY State Standards:

Chemistry St. 4, 3.1v: Elements can be classified by their properties and located on the Periodic Table as metals, nonmetals, metalloids (B, Si, Ge, As, Sb, Te), and noble gases.

Chemistry St. 4, 3.1w: Elements can be differentiated by physical properties. Physical properties of sub- stances, such as density, conductivity, malleability, solubility, and hardness, differ among elements.

Chemistry St. 4, 3.1x: Elements can also be differentiated by chemical properties. Chemical properties describe how an element behaves during a chemical reaction.

Chemistry St. 4, 3.1y: The placement or location of an element on the Periodic Table gives an indication of the physical and chemical properties of that element. The elements on the Periodic Table are arranged in order of increasing atomic number.

Chemistry St. 4, 3.1aa: The succession of elements within the same group demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.

Chemistry St. 4, 3.1bb: The succession of elements across the same period demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.

Materials:

Lead check swabs, PRO-LAB do-it-yourself lead-in-water test kit

Procedures

Initiating:

Ask students: If you go to Barns and Noble, how do you find a particular book or CD? Ask students to explain why bookstores organize books by action, cookbooks, drama, history, science, and religion. Explain to students that they will learn how periodic table is organized and how elements are grouped.

- Explain the organization of periodic table.
- Identify group within the periodic table and state what properties elements in-group have in common.
- Discuss physical and chemical properties of metals.
- Introduce guest speaker (Invite local medical doctor or someone form Health a Department to come and talk about the dangers of lead exposure. Ask the speaker to talk about ways to identify lead sources in the home and procedures for blood lead testing)
- Ask students how many have had their house water tested for lead.

Transacting:

In this activity we focus on Lead (Pb). As you learned from the guest speaker lead can be toxic to human when ingested at low level over period of time. Many other metals or semi-metals such as zinc, arsenic, gold, silver, cadmium, or mercury can also cause health problems. Most exposure to these metals occurs in industrial settings. For example, worker in a smelter might be exposed to trace amounts of metals as they process ores. Exposure can occur in many other ways. Mercury for example is found in dental fillings, batteries, paints, dyes. Arsenic is found in pesticides, and rodenticides. We have to make sure that we properly dispose those products otherwise trace metal may be release to environment. In this activity we focus on Lead (Lb) exposure. You will test common object for lead.

1. Pass the lead check swabs and PRO-LAB do-it-yourself lead-in-water test kit to the students.
2. Demonstrate the proper way of using the lead testing kits.
3. Demonstrate how to handle the various test objects.
4. Have the student's test the objects listed in the data table below, fill in the table, and analyze and discuss data.

Objects	Lead Present (Pink)	Lead Not Present (No color change)	Comments/observations
Toys			
Lead and copper pipes			
Lipstick			
Jewelry			
Decorative figurines			
Food cans			
Glassware			

Applying and exploring:

1. Give the class additional swabs and PRO-LAB do-it-yourself lead-in-water test kit to take home.
2. Have students test water, furniture, pipes and two items of their choice that raise their concerns.
3. Have students create table (like the one used in class) and list all items tested.
4. Have students write a two paragraph report explaining what precautions they will take now and in the future to reduce their family's exposure to high levels of lead as a basis for their conclusions.

Assessment:

- Collect students' write-ups about lead.
- In three to four paragraphs have students describe properties of iron (Fe). Ask students to brainstorm different uses of iron in society. Remind students that steel is alloy composed mostly of iron. Ask students to explain why properties of iron

are so valuable and have students hypothesize how industrial development might have been different if iron had not been available.

Implementation Recommendation:

- Periodic table and periodicity
- Groups of elements, metals.

Fertilizers

Objective:

Students will be able to:

- Relate the properties of chemical elements they learn in the class to agriculture.
- Explain chemical composition of fertilizers and to calculate present yield.

NY State Standards:

Chemistry St. 4, 3.3 f: The present composition of each chemical element in a compound can be calculated mathematically.

Chemistry St. 4, 3.1x: Elements can also be differentiated by chemical properties. Chemical properties describe how an element behaves during chemical reaction.

Chemistry St. 4, 3.1 cc: A compound is a substance composed of two or more different elements that are chemically combined in a fixed proportion. A chemical compound can be broken down by chemical means. A chemical compound can be represented by a specific chemical formula and assigned a name based on the IUPAC system.

Materials:

Soil Test Kits

Initiating:

To grab students attention visits or invite local farmer to class. Make sure he/she covers types of fertilizers and purpose of fertilizer use.

Transacting:

1. Depending on the situations (If you on farm ask the farmer for permission to perform soil tests on his/her farm or if invited the farmer to class ask him to bring generous amount of sail).

2. Pass out soil test kits, one per group of two.
3. Have students to test the soil and report the test results in lab notebooks. (Make sure that students get familiar with the kits before they start testing the soil)

Applying and Exploring:

Have students' answers the following questions.

1. Soil test allows farmers to examine soil type, soil quality, and what nutrients need to be added to the soil for plant crop requirement. The farmer then chooses fertilizer combinations that will best meet the needs of the particular situation. Based on your soil test, suggest fertilizer that would be best for the soil that you tested. Explain your answer.
2. List chemical elements essential for plant nutrition.
3. Ammonium nitrate is used as a fertilizer; ammonia is also used as a fertilizer. Compute the percentage of nitrogen in each. If both cost the same amount per ton, which is the better buy in terms nitrogen of content?
4. A farmer has two different fertilizers in her barn. One is K_2SO_4 and the other is KCI. The two fertilizers cost the same per ton, but she wants to use the one with the highest percentage of potassium. Which fertilizer should she use? Substantiate your explanation with numbers.
5. Animal manures are often used to add nutrients to soils. Assume that the average price for chicken manure is $ 15 per ton and contains 31 lbs. of nitrogen per ton.
    a. Calculate the percentage of nitrogen in the chicken manure?
    b. What is the cost per pound of nitrogen?
    c. What is the cost of calcium nitrate?

d. What is the cost ammonia nitrate?

e. When applying chicken manure, calcium nitrate or ammonia nitrate as fertilizer, which is more cost effective? Explain

Assessment opportunities:

To assess students understanding collect students respond to the question 1-5 from applying and exploring section.

Implementation Recommendation:

This lesson can be implemented into unit on:

- Stoichiometric calculation
- Ionic compounds and metals
- Periodic table and periodic law

Chemistry of Pesticides

Objective:

Students will be able to:

- Describe the chemical structure and mode of action of pesticides.
- Identify and discuss possible environmental and health hazards associated with pesticide use and exposure.

NY State Standards:

Chemistry St.4, 3.1cc: A compound is a substance composed of two or more different elements that are chemically combined in a fixed proportion. A chemical compound can be broken down by chemical means. A chemical compound can be represented by a specific chemical formula and assigned a name based on the IUPAC system.

Chemistry St.4, 3.1dd: Compounds can be differentiated by their physical and chemical properties.

Chemistry St.4, 3.1ee: Types of chemical formulas include empirical, molecular, and structural.

Materials:

Laptops with Internet access,

Procedures

Initiating:

1. Start class with discussion about pesticides. Point out that pesticides are commonly used both in home gardening and commercial agriculture. However, as synthetic substances, these products can cause problems if not used properly.
2. Show students empty containers of several household pesticides items. Have

them read the labels, the product trade name and chemical name.

3. Have students discuss why we use pesticides and explain what pests they are targeting.
4. Ask students to list the benefits and disadvantages of using pesticides?
5. Distinguish between element and compound.
6. Explain the difference between empirical, molecular, and structural formulas.
7. Briefly explain nomenclature.

Transacting:

1. Have students choose a commonly used pesticide to research.
2. Have the students conduct an Internet search of the pesticide. Have them find the following information:
    - Common name of pesticide.
    - Trade name of pesticide
    - Type of pesticide
    - Chemical formula
    - Formulation (e.g., granular, liquid, gas)
    - Mode of action (how does it affect the organism from a biochemical standpoint)
    - Physical properties (e.g., molecular weight, water solubility, melting point)
    - Toxicological effects (e.g., acute toxicity, chronic toxicity, reproductive effects, mutagenic effects, carcinogenic effects)
    - Ecological effects (e.g., on birds, aquatic organisms, bees, mammals)

- Chemical versus natural pesticides
- Environmental fate (e.g., does it break down in soil, is it transported easily in groundwater)

3. Have students present the information in visual presentation of their choice (example: PowerPoint, poster).

Applying and expanding:

1. Have students' research and write a two to four page report about Rachel Carson's influence on American culture and on public policy to protect the environment.

Assessment

To assess students performances use their visual presentation and report about Rachel Carson.

Implementation Recommendation:

This activity can be implemented when teaching, about, unit on matter properties and changes, chemical formulas or nomenclature.

Measuring pH of soil

Objective:

Students will be able to:

- Explain pH
- Identify the physical and chemical properties of acids and bases.
- Classify substances as acidic or basic

NY State Standards:

Chemistry St. 4, 3.1uu: Behavior of many acids or bases can be explained by the Arrhenius theory. Arrhenius acids and bases are electrolytes.

Chemistry St. 4, 3.1tt: On the pH scale each decrease of one unit of the pH represents a tenfold increase in hydronium ion concentration.

Materials:

pH probe, filter paper, beaker, funnel, 4 different soil samples (farm land, park, water, vegetable garden, orchard, wetland), petri dish, CaO, FeO_4.

Procedures

Initiating:

- Start lesson with pictures of hydrangeas posted on a smart board, (one with blue flowers one with pink flowers). Explain to students that hydrangeas produce blue flowers when grown in acidic soil, and pink when grown basic soil.
- Next define pH scale and explain how the pH scale is used.
- Identify the physical and chemical properties of acids and bases.
- Identify buffers and explain how they work.
- Start discussion about agriculture now and in the past. (Technology and science

contribution to greater yield with less labor).

Transacting:

Farmers use fertilizers to replace nutrition lost from the soil, and to increase crop production. In this lab we will measure the pH of different soil samples. Soil test will enable you to adjust your soil's pH level and determine whether it's neutral, alkaline or acidic Place 25 grams of soil in a beaker and add 50 mL of distilled water. Stir the mixture well, and pour the mud into funnel with a piece of filter paper. Allow the water to drain and measure the pH with a pH probe. Report your measurements. What does the pH measurements indicate? (They indicate that some soils are too acidic while other too basic for optimal growth). CaO and $FeSO_4$ are commonly use by farmers to monitor the pH of soil. First measure the pH of CaO and $FeSO_4$, and than decide which soil would benefit from CaO, and which would benefit $FeSO_4$. Add the desire mineral to each soil sample and repeat pH measurements. Which mineral CaO or $FeSO_{4,}$ would you add to a soil that is to acidic?

Applying and Expanding:

Have students brainstorm and answer the following questions:

1. What environmental problems occur if application rates of fertilizers are well below/above recommended rates?
2. Is the economic optimal fertilizing intensity in conflict with environmental consideration?

Assessment opportunities:

To assess understanding collect lab reports and answers to question 1 and 2 from applying and expending.

Implementation recommendation:

Implement this lesson into unit on acids and bases chemistry.

Cleaning Mechanism of Soap

Objectives:

Students will be able to:

- Describe saponification as the hydrolysis in basic solution of fats and oils to produce glycerol and salts of fatty acids.
- Describe the conditions under which saponification can be preformed
- Define how surfactants have a distinct molecular structure that gives rise to their molecular properties.
- Determine how soap, polar solution and oil together form an emulsion with soap acting as the emulsifier.

NY State Standards:

Chemistry St. 4, 3.2c: Types of organic reaction include: addition, substitution, polymerization, esterification, fermentation, saponification, and combustion.

Materials:

Ring stand, Bunsen burner, 600 ml beaker, 50ml beaker, pipette, mold,

Liquid lye solution of choice (NaOH or KOH)

Fats of choice (Cannoli oil, peanut oil, corn oil, sunflower oil, soy wax, flex seed oil, Shea butter, bees wax)

Liquid of choice (milk, water, green tea)

Procedures:

Initiating

- Ask students if they ever tried to wash greasy dishes with just water.
- What happened?

- Ask what happens when soap is added.
- Discuss the cleaning mechanism of soap.
- Discuss the physical process by which soap solubilizes dirt.
- Pass out different soap bars; discuss the history of soap and how soap is made.

Transacting:

This lab will use a "melt and pour" procedure for soap making. The fats will be melted in a hot water bath, neutralized with lye and then poured into a mold. First, use the Lye Calculator™ at the following website to calculate mass of lye that will be used with the fats o calculate mass of lye that will be used with the fats of you choice.

http://www.the-sage.com/calcs/lyecalc2.php

Lab procedures overview

1. The first step to soap making begins by making a concentrated aqueous solution of a strong base, such as sodium hydroxide or potassium hydroxide. In this lab you may use sodium hydroxide or potassium hydroxide. The sodium hydroxide gives a firm solid soap, and the potassium hydroxide gives a softer, more fluid soap.

2. The second step is to choose a fat(s) and measure an exact mass of this fatty acid. In this lab there are many fats you may use.

3. The third step is to heat the fatty acid above the melting point, so that becomes a liquid. If the fat is heated too fast or too hot, it will burn. The best method to heat the fatty acid, oil or wax using a double boiler, or water bath. A burner heats a container of water, and the hot water heats another container of fatty acid.

4. The fourth step is to carefully calculate an exact volume of strong base to slowly add to the hot, liquid fatty acid. In this lab, it must be an exact mole-to-mole match of a NaOH

for each fatty acid. The lye calculator™ from the Internet will be used to assist in the calculation of the saponification number (SAP) value.

5. The fifth step is to mix the strong base and fatty acid. The sodium hydroxide solution is slowly added to hot liquid fatty acid with strong rapid stirring. This is the saponification reaction. The soap has a higher melting point then the fatty acid, so the mixture will form a solid as the strong base is added to the fatty acid.   This semisolid mixture is called a “trace”, because you can trace your initials into the mixture. After all of the sodium hydroxide is added, the “trace” is removed from the heating container and placed into a mold to cool.

Applying and expanding:

Have students answer the following questions:

1. Explain why hard water causes a “bathtub ring.”

2. Determine which is the polar and which is nonpolar end of the soap molecule.

3. When surfactants aggregate they form micelles. Why does a micelle form?

4. What happens on the molecular level when you wash a greasy dish?

5. Why is it necessary to have a strong base present in the saponification process?

Assessment:

To assess students understanding collect students respond to question 1- 5, form applying and exploring.

Implementation recommendation:

This is great activity to spark students’ interest in organic chemistry.

Fruity Smells: Making Esters

Objectives:

Students will be able to

- Identify three types for of organic compounds (alcohol, acid and esters) from chemical structure or condensed molecular formulas.
- Name ester compounds.
- Describe the process of esterification
- Describe the applications of organic chemistry to the food and cosmetic industry.

NY State Standards:

Chemistry St 4, 3.1ff: Organic compounds contain carbon atoms, which bond to one another in chains, rings, and networks to form a variety of structures. Organic compounds can be named using the IUPAC system.

Chemistry St. 4, 3.1hh: Organic acids, alcohols, esters, aldehydes, ketones, ethers, halides, amines, amides, and amino acids are categories of organic compounds that differ in their structures. Functional groups impart distinctive physical and chemical properties to organic compounds.

Chemistry St. 4, 3.2c: Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion.

Materials:

Bunsen burner, ring stand, ring, wire gauze, 500 mL beaker, beaker tongs, test tube, boiling chip, watch glass, pipettes: carboxylic acid, alcohol, 18M H_2SO_4, balance.

Procedures:

Initiating

Discussion/background:

Ask students: Have you ever eaten a piece of fruit-flavor candy that taste like fruit? Explain that many natural fruits, such as banana or strawberries, contain dozens of organic molecules that combine to give the distinctive aroma and flavor of fruits. Esters are very popular artificial scents and flavors added to a wide array of consumer products, like soft drinks, chewing gum scented wax candles, car fresheners, deodorizers, and food flavorings. Esters are easily made in the laboratory from their corresponding carboxylic acid and a condensation reaction with an alcohol.

- Explain how several classes of organic compounds can be derived from hydrocarbons.
- Identify the differences among alcohols and esters.
- Review four general types of chemical reactions; double replacement, single replacement, synthesis and decomposition.
- Explain esterification.

Esterification is an organic synthesis reaction that combines an alcohol with an acid to form an acid and water. It is a synthesis type of reaction. In biology, this type of reaction is called dehydration synthesis, because it removed a water molecule (dehydration) to make (synthesis) the ester.

$$\text{Energy} + \text{A-COOH}_{(l)} + \text{OH-B}_{(l)} \xrightarrow[\text{heat}]{H_2SO_4} \text{A-COO-B}_{(l)} + H_2O_{(l)}$$

The sulfuric acid is added as a catalyst. A catalyst is not a reactant or product. It just speeds up the rate of the reaction, or increases the speed. The sulfuric acid helps to dehydrate the reactants, or remove the water from the acid and alcohol.

Transacting:

In this lab we will investigate what fragrances are produced when esters are formed from combinations of different alcohols with different carboxylic acids**.**

1. Carefully add 10 drops of concentrated sulfuric acid (H_2SO_4). This chemical must be added after the other chemicals. The H_2SO_4 acts as a catalyst and a dehydrating agent, which forces the condensation reaction between the alcohol and the carboxylic acid.
2. Gently tap the tube to mix the reactants and add the boiling chip.
3. Fill your beaker about 1/3 full of water. Place the test tube into the beaker of water. Make sure that the level of chemicals in the test tube is below the level of water. Cover the beaker with a watch glass. This is to prevent the alcohol fumes from igniting by the open flame.
4. Heat for about 10-15 minutes in the water bath.
5. Turn off the heat, remove the test tube and carefully smell your newly synthesized ester.
6. Smell the esters that other students made and try to identify their odors.
7. Write the chemical reactions for each of the esters produced.
8. Fill in the ester recipes table.

Ester Recipes Table

Alcohol	+	Carboxylic acid	=	Ester	Formula of ester	Flavor
42 drops n-butyl alcohol		40 drops acetic acid		Butyl acetate		
30 drops octyl alcohol		15 drops acetic acid		Octyl acetate		
45 drops amyl alcohol		30 drops acetic acid		Amyl acetate		
30 drops ethanol		30 drops butyric acid		Ethyl butyrate		
30 drops methanol		20 drops butyric acid		Methyl butyrate		
40 drops methanol		0.5 grams salicylic acid		Methyl salicylate		

Applying and Exploring

Ask students to answer questions below.

1. Which functional group do methanol, and propanol contain and what are the characteristics of this functional group?

2. The esters produced in this laboratory experiment contain what functional group and what are the characteristics of all ester?
3. Describe how the reaction between carboxylic acid and alcohol accounts for the general formula of ester.
4. Isobutyl alcohol and formic acid combine to produce a raspberry odor. Predict the name of the ester.
5. Research and list the chemical compositions and structure of your favorite scents, include chemical name and structure.
6. Evaluate the advantages and disadvantages of using synthetic in consumer products as compare to using natural esters.

Assessment opportunities:

To assess understanding ask students to explain the esterification reaction, list and explain uses of synthetically produced esters.

Implementation recommendation:

This is great activity for organic chemistry or reaction types (synthesis/ esterification).

Household Chemicals

Objectives:

Students will be able to:

- Identify the physical and chemical properties of acids and bases.
- Classify solutions as acid, base, or neutral upon the pH,
- Balance equations, given the formula for reactants and products

NY State Standards:

Chemistry St. 4, 3.1ss: The acidity or alkalinity of an aqueous solution can be measured by its pH value. The relative level of acidity or alkalinity of these solutions can be shown by using indicators.

Chemistry St. 4, 3.2b Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement.

Materials:

Common household cleaners (Clorox, Tide detergent, Windex….), pH probe, label test tubes for household cleaners, wash bottle to raise probe,

Procedures:

Initiating:

- Start with class discussion. Perhaps you are planning to do a spring-cleaning and you are looking for an excellent cleaner. Bleach (sodium hypochlorite) is a common household cleaner, used in huge qualities around the world as a laundry whitener, a disinfectant used in cleaning, waste and swimming pools. When you look at bottle of bleach, do you ever wonder why you should not mix bleach with ammonia? That warning on the bottle of bleach is there to protect you. You maybe surprised at the number of cleaning products that can cause a dangerous situation when mixed. Be sure to always read the product labels before using household cleaner and remember to never mix bleach with ammonia or acids.

- State definition of acids and bases
- Describe the similarities and differences in physical and chemical properties of acids and bases.
- Explain the relationship between the strengths of acids and bases and the values of their ionization constant.
- Explain pH and pOH.

Transacting:

In this activity, you will differentiate between acids and bases using the pH scale. You will predict the acidity or alkalinity of several household chemicals then use pH probes to determine experimentally the actual pH of the substance.

1. Write the reaction of bleach (NaOCl) with ammonia (NH_3) on the board and have students balance the equation. Next, have students examine and discuss the products of reaction

$$NaOCl + NH_3 \rightarrow NaONH_3 + Cl_2$$

2.Write on board another potential reaction that takes place when a greater amount of bleach is added than ammonia and have students balance the equation. Next have students examine and discuss the products of reaction.

$$NaOCl + NH_3 \rightarrow NaOH + NCl_3$$

3. pH probes will be use to experimentally determine pH of common household cleaners. Pass out a set of common household cleaners and ask students examine product labels

and to predict if given substance is acid or base. Next have students use pH probe to test predictions. Record data.

Sample data recording Table

Substance	Prediction acid/base/neutral	pH	Answer acid/base/neutral
Clorox			

4. Describe chemical reaction that take place when acidic solution is mixed with basic solution.

Applying and expanding:

Have students answer the following questions.

1. What effects chlorine gas has on human body?
2. What are poisons and how they harm you?
3. As you know many everyday household chemicals contain hazardous chemicals, make a list of safe alternatives to common household cleaning products.

Assessment:

Ask students to write chemical equation and K_b expression for ionization of ammonia in water, and explain how is it safe for window cleaner to use a solution of ammonia, which is basic.

Implementation Recommendation:

This lesson can be easy implemented into unit on acid and base chemistry.

Biodiesel Fuel

Objective:

Students will be able to:

- Compare fuels
- Understand the impact of different types of fuel on: the environment, lifestyle, the economy
- Understand the magnitude of transportation energy use, and the energy displacement potential of biofuels.
- Understand that chemical structure of biodiesel is described as a mono alkyl ester of long chain fatty acids derived from natural oils.
- Understand that biodiesel is derived from three reactants: glyceride (oil), alcohol and a catalyst.
- List and compare various types of materials that are used to make a biofuel.

NY State Standards:

Chemistry St. 4, 3.2b: Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement.

Chemistry St. 4, 3.2c: Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion.

Chemistry St. 4, 3.1gg: Hydrocarbons are compounds that contain only carbon and hydrogen. Saturated hydrocarbons contain only single carbon-carbon bonds. Unsaturated hydrocarbons contain at least one multiple carbon-carbon bond.

Chemistry St. 4, 4.1d: Energy released or absorbed during a chemical reaction (heat of reaction) is equal to the difference between the potential energy of the products and potential energy of the reactants.

Materials:

Hotplate (with magnetic stirrer), vegetable oil, lye (NaOH), methanol, Erlenmeyer flask,

Procedures

Initiating:

Lead class discussion and point out that energy demands are increasing but fossil fuels are becoming limited. As a result, there is increasing interest in developing alternative energy resources.

Ask students what are some alternative energy resources (hydrogen cells, solar energy, thermal energy, and wind power).

Ask students if they know any one who uses biodiesel to run their car.

Introduce guest speaker (local chemistry professor that collect used oil form restaurants and uses it to run his car, or one of RIT professors that specialize in biofuels). Make sure that the speaker explains that biodiesel is a renewable fuel made from any biologically based oil, biodegradable, nontoxic, environmentally friendly because it has lower CO and hydrocarbon emissions than petroleum-based diesel when burned, and can be used to power any diesel engine.

Transacting:

In this lab we will make biodiesel. The reaction that converts vegetable oil into biodiesel is known as transesterification, which is similar to saponification.

Vegetable oil is composed of triglycerides, which are glycerol-based esters of fatty acids. Triglyceride is too thick to burn properly in a diesel engine at room temperatures. In this lab in order to make biodiesel you will convert the triglycerides from glycerol-based esters to methyl esters of fatty acids.

1. Place magnetic stir bar into 1000 ml Erlenmeyer flask and add 100 ml of Methanol.
2. Drop 1.75 grams of lye into the flask.
3. Turn on the magnetic stirrer and turn the heat up to 35°C.
4. Let it mix for about 10 minutes, (there will be no lye grain)
5. Turn the hot plate, and add 500 ml of vegetable oil into the methanol and lye solution. Stir for about 10 minutes.
6. Settle a side for 24 hours.
7. Design experiment to test your product.

Post Lab Questions:

1. Which substance in this reaction is the catalyst?
2. Explain why is sodium hydroxide (lye) necessary production of biodiesel.
3. How might our processing technique be improved to make a better biodiesel product?
4. How can biodiesel contribute (if you feel it can at all) to our future?

Applying and Exploring

1. Have students calculate the cost of biofuel per gallon and compare to the cost of petroleum.

Assessment

1. Have students explain what impact that burning hydrocarbons have on the environment.
2. Have students explain why biofuels are better alternative to petroleum-based fuels?

(Have students list and explain possible factors that might make a biofuel a good alternative to the fuels used today)

3. Have students list and explain possible disadvantages of using biofuel?

Implementation recommendation:

This lesson can be implemented when teaching organic chemistry, to spark students' interest in alternative fuel sources and to explore transesterification and esterification reactions.

Petroleum- Black Gold

Objective:

Students will be able to:

- Understand the process of crude oil refinement
- Understand octane rating of gasoline and chemistry learn in class to daily life.

NY State Standards:

Chemistry St. 4, 3.1gg: Hydrocarbons are compounds that contain only carbon and hydrogen. Saturated hydrocarbons contain only carbon-carbon single bonds. Unsaturated hydrocarbons contain at least one double bond.

Materials:

Bunsen burner, large beaker, large test tube, rubber stopper-rubber tubing assembly, water pan, ring stand and claps, mineral wool, liquid paraffin, dilute potassium permanganate, laptops with Internet access

Procedures

Initiating:

Begin Lesson with discussion: We know that petroleum is used to make gasoline. But what other products are made from petroleum?

1. Ask students to list petroleum products that they use daily.
2. Make sure that students understand that petroleum product, are hydrocarbons.
3. Discuss our use of petroleum products and point out that customer demand for petroleum-based products has increased.
4. Explain that petroleum is a complex mixture of more than thousand different components and has little practical use.

5. On Smart Board post diagram of fractionating tower and explain fractional distillation.
6. Explain cracking (thermal cracking and catalytic cracking)

Transacting

With this activity you will simulate the commercial process of hydrocarbon cracking. Before conducting the activity, please carefully view the video clip on setting up the cracking, activity apparatus. Make sure to record the procedural steps in your laboratory notebook. Link to video: http://media.rsc.org/videoclips/demos/crackingahydrocaron.mpg Bases on the video in groups of two preform hydrocarbon cracking and record observation in lab notebook.

Applying and Exploring

Considering that most abundant hydrocarbon in petroleum deposits are large straight chain molecule, which do not yield high quality gasoline. Conversion to branch chain improves gasoline performance. Catalytic cracking produces not only alkenes, but also a greater amount of branch chain and ring compounds. These compounds increase octane ratings, and improve the antiknock quality of gasoline. Research and prepare a presentation that explains octane rating. Your presentation should contain information about tetraethyl lead in gasoline and how it affects octane rating.

Assessment:

Assess students understanding based on their presentation (ask question during or after presentation to check and clarify students understanding of concept)

Implementation recommendation:

This lesson is great addition to unit on organic chemistry.

Alternative Energy

Objectives:

Students will be able to:

- Understand that energy cannot be created nor destroyed (1st law of thermodynamics). Energy is stored (in chemical bonds, nuclear bonds, and gravitational energy) and then released in a different form (electricity, heat, motion and sound)
- Analyze the advantages and disadvantages associated with the following energy sources: coal, natural gas, hydrogen, geothermal, hydropower, oil, solar, wind, and nuclear energy.
- Predict the economical and environmental values of choosing to use alternative energy sources.

NY State Standards:

Chemistry St. 4, 4.1a: Energy can exist in different forms, such as chemical, electrical, electromagnetic, thermal, mechanical, nuclear.

Chemistry St.4, 4.1b:Chemical and physical changes can be exothermic or endothermic.

Chemistry St.4, 4.1c: Energy released or absorbed during a chemical reaction can be represented by a potential energy diagram.

Chemistry ST.4, 4.1d: Energy released or absorbed during a chemical reaction (heat of reaction) is equal to the difference between the potential energy of the products and potential energy of the reactants.

Chemistry St. 4, 3.3a: In all chemical reactions there is a conservation of mass, energy, and charge.

Materials:

Computers with Internet access

Procedures:

Initiating:

Start with discussion. We use energy in almost every aspect of our live; it simply makes our lives easier. The United States alone consumes 25 % of the world's energy each year, while contains only 5 % of the world's population. Most of energy used in the United States comes form non-renewable sources such as coal, oil and natural gas. Not only we are rapidly reducing our energy sources, we are also increasing pollution in process.

Ask the students to discuss renewable energy. What is renewable energy? What types of energy are considered 'renewable'? Why is renewable energy important?

Before moving on to transacting section of the lesson review the following concepts:

- Law of conservation of energy.
- Distinguish between potential and kinetic energy.
- What is specific heat and how to calculate heat absorbed and released.
- Hess law, enthalpy and enthalpy changes.
- Thermochemical equation.

Transacting

Geothermal energy is great and clean source of alternative energy, Advances in technology and government support are increasing geothermal energy production in the United Sates. Homeowners across the United States are searching for more efficient ways to get more out of their energy dollars. Geothermal heat pumps can solve this problem. Not only it costs less to operate geothermal system than any other heating and cooling system, it also preserves our natural resources. Ask the students to perform a web search and create an informational brochure for people in your community about geothermal technology. Laptops will be available in class for two days. The brochure should include: (What is a geothermal heat pump and how does it work? How is the heat transferred between the earth and the home? What are major benefits of geothermal energy? What does system a system like this cost? Explanation of residential geothermal tax credit. What type of geothermal system would be most appropriate for your state, town, school, or house? What savings, in both electricity and dollars, could a geothermal system provide to your community?)

Assessment:

The content of students brochure will be used to assess students understanding of topic.

Implementation recommendation:

Energy and Matter, Thermochemistry

Nuclear Power pros and cons

Objective:

Students will research and report on the advantages and disadvantages of the nuclear power industry

NY State Standards:

Chemistry St. 4, 4.4a: Each radioactive isotope has a specific mode and rate of decay (half-life).

Chemistry St. 4, 4.4b:Nuclear reactions include natural and artificial transmutation, fission, and fusion.

Chemistry St. 4, 4.4c: Nuclear reactions can be represented by equations that include symbols which represent atomic nuclei (with mass number and atomic number), subatomic particles (with mass number and charge), and/or emissions such as gamma radiation.

Chemistry St. 4, 4.4d: Radioactive isotopes have many beneficial uses. Radioactive isotopes are used in medicine and industrial chemistry for radioactive dating, tracing chemical and biological processes, industrial measurement, nuclear power, and detection and treatment of diseases.

Chemistry St. 4, 4.4e: There are inherent risks associated with radioactivity and the use of radioactive isotopes. Risks can include biological exposure, long-term storage and disposal, and nuclear accidents.

Chemistry St. 4, 4.4f: There are benefits and risks associated with fission and fusion reactions.

Materials:

Laptops with Internet access,

Procedure

Initiating:

Start lesson with discussion about 2011 explosion at nuclear power plant in Japan.

Facilitate a class discussion about the advantages and disadvantages of nuclear power.

Allow students to formulate their own ideas.

Review and teach the following concepts:

- Identify alpha, beta, and gamma radiation in terms of composition and key properties.
- Explain why certain nuclei are radioactive.
- Comparing and contracting nuclear fission and fusion.
- Explain the process by which nuclear reactor generates energy.

Transacting:

Pass out laptops and have students' research the impact of nuclear power, historically, presently and for our future? Have students' complete four-page research paper about the advantages and disadvantages of nuclear power, and environmental effects of nuclear waste on air and water.

Applying and Expending:

R. E. Ginna Nuclear Power Plant is located in Ontario, NY, 20 miles North East of Rochester. Since it is one of the oldest nuclear power reactors still in operation in the United States, Rochester community should be aware of emergency protection procedures in the event of radiological emergency. Gather as much information as possible about Nuclear Power Plan located in our community. What are the emergency protection procedures in the event of a radiological emergency at the R.E. Ginna Nuclear Power Plant? How can the public become involved in the emergency planning and preparedness process? What are the 10-mile and 50-mile emergency planning zones? Once you gather all necessary information, create an emergency protection procedures flyer for people in your community.

Assessment:

Assess students understanding based on research paper and informational flyer.

Implementation recommendation:

Implement this lesson into unit on nuclear chemistry

Radioisotope

Objectives:

Students will:

- Learn about the discovery of radium and radioactivity.

- Understand the process of radioactive decay.

- Perform an experiment to better understand half-life

NY State Standards:

Chemistry St. 4, 4.4a: Each radioactive isotope has a specific mode and rate of decay (half-life).

Chemistry St. 4, 4.4b: Nuclear reactions include natural and artificial transmutation, fission, and fusion.

Chemistry St. 4, 4.4c: Nuclear reactions can be represented by equations that include symbols which represent atomic nuclei (with mass number and atomic number), subatomic particles (with mass number and charge), and/or emissions such as gamma radiation.

Chemistry St. 4, 4.4d: Radioactive isotopes have many beneficial uses. Radioactive isotopes are used in medicine and industrial chemistry for radioactive dating, tracing chemical and biological processes, industrial measurement, nuclear power, and detection and treatment of diseases.

Chemistry St. 4, 4.4e: There are inherent risks associated with radioactivity and the use of radioactive isotopes. Risks can include biological exposure, long-term storage and disposal, and nuclear accidents.

Chemistry St. 4, 4.4f: There are benefits and risks associated with fission and fusion reactions.

Materials:

Lab notebooks,

Procedures:

Initiating:

1. Ask students if they can define the term radioactivity. Make sure they understand that radioactivity is technically defined as the property of some elements or isotopes of spontaneously emitting particles of energy by the disintegration of their atomic nuclei.

2. Ask students to list consumer products involving the use of radiation.

3. Have students list thing that change spontaneously without human help.

- Point out that, unstable nucleus is radioactive and undergoes spontaneous nuclear reaction to become more stable.

4. Explain the following concepts before proceeding with the activity:

- The disintegration of the atomic nuclei of radioactive materials is known as radioactive decay.
- Half-life.
- The half-lives of different radioactive materials can be anywhere from billions of years to a few seconds long.

-Transacting:

As an environmental scientist/radiation technician your job involves analyzing samples of soil contaminated by different waste. Today you will analyze sample of soil contaminated by radioactive waste. You have to measure the half-life of a radioisotope that decay very fast, about 30 minutes. Unfortunately, your equipment can only measure a decay rate of one disintegration every 3 seconds.

1. Have the students design an experiment to determine the half-life of this radioisotope?
2. Have the students list all precautions that should be taken before making any measurements.
3. How would you check your results?

Applying and Expanding:

Invite local environmental scientist to class. (Make sure that the guest speaker discusses his/her educational preparation, job and environmental issues in students' community)

Assessment opportunities:

Use experiment design by students to assess understanding of concept.

Implementation recommendations:

Implement this lesson into unit about nuclear chemistry.

Radiation Therapy

Objectives:

Students will be able to

- Describe several methods used to detect and measure radiation.
- Explain application of radiation used in the treatment of disease.
- Describe some of the damaging effects of radiation on biological systems.

NY State Standards:

Chemistry St. 4, 4.4a: Each radioactive isotope has a specific mode and rate of decay (half-life).

Chemistry St. 4, 4.4d: Radioactive isotopes have many beneficial uses. Radioactive isotopes are used in medicine and industrial chemistry for radioactive dating, tracing chemical and biological processes, industrial measurement, nuclear power, and detection and treatment of diseases.

Chemistry St. 4, 4.4e: There are inherent risks associated with radioactivity and the use of radioactive isotopes. Risks can include biological exposure, long-term storage and disposal, and nuclear accidents.

Materials:

Geiger counter, comic books

Procedures

Initiating:

Start class by passing out comic books that feature superheroes such as Spiderman or the Incredible Hulk. Ask Students what do these superheroes have in common? Have students describe the history of these superheroes. Ask how realistic are these stories? What effects does exposure to radiation have in real life?

Transacting:

Facilitate class discussion. Discuss biological effects of radiation, units of radiation, effects on radiation on living tissues, dosimeter (device that measure the total amount of radiation that person has received) and Geiger counter (device that detects radiation). Explain that different types of radiation penetrate differently. Demonstrate that piece of paper will effectively block alpha particles, piece of wood will effectively block beta particles, and lead shield will effectively block the penetration of gamma particles. Finally discuss the beneficial uses of radioisotopes. Ask students do benefits of varying application of radioisotopes outweigh the risks involved in their use? (Examples should support answer).

Applying and Expending:

Have students go and interview radiologist in their community, at one of local hospitals, Department of Radiology at the University of Rochester Medical Center, or at any medical imaging facility. If students will have difficulty-arranging interview, invite local radiologist to class.

Simple questions:

- What type of training a radiologist must have?
- What radiologist does, what kinds of radiations are used?
- What are the safety precautions to protect both patient and radiologist?
- Types of radiation therapy for cancer patients.
- Ways in which radiation may damage organisms.

- What is permissible maximum dosage of radiation that a worker may receive?
- What are most common sources of radiation in daily life?

Have students write interview report.

Assessment opportunities:

Use the interview report to assess students' understanding use the interview report.

Implementation recommendation:

Implement this lesson into a unit about nuclear chemistry.

Water quality testing

Objective:

Students will understand that water is essential for living things to survive. Water quality testing of local lakes, rivers and streams introduces students to environmental and economical water quality issues in their community.

NY State Standards:

Chemistry St 4, 3.1s: Mixture is composed of two or more different substances that can be separated by physical means. When different substances are mixed together, a homogenous or heterogeneous mixture is form.

Materials:

Water samples, water quality monitoring test kit or probe ware

Procedures

Initiating:

Begin with a general discussion of water quality and why is so important. Next discuss water quality parameters. Select with students water source (local lake, river or stream) and exact location for class investigation.

Transacting:

In this investigation will test the quality of water over the period of five week.

1. Once a week for 5 weeks bring a sample of water.
2. Hand out water quality monitoring test kits/ probe ware.
3. Give students 10 minutes to become familiar with their water quality testing kits/ probe ware.
4. In groups of two have students preform water quality tests.

5. Have students' record data.

6. Repeat step 4 and 5, once a week for five weeks.

7. Once all data is collected, each student should construct a data sheet and a graph in EXCEL, write a summary report, analyzing the data and making conclusions concerning human impact on water quality. The graph have to show normal limits compared to test data.

Sample data table

Water Parameter	Week 1	Week 2	Week 3	Week 4	Week 5	Comments
pH						
Dissolved Oxygen						
Nitrogen						
Phosphorous						
Turbidity						

Applying and Expending:

1. Ask students to identify potential sources of pollution along selected water source (lake, river, steam)

2. Ask students to develop a plan to eliminate/decrease pollution and improve quality of water.
3. Ask students to identify potential sources of pollution in their community and homes.

Assessment opportunities:

1. Ask students to describe the chemistry of the substances being tested, its use and potential as pollutant.
2. Ask students to describe sources of tested substances.
3. Ask students to describe negative effects of water pollution.

Implementation recommendation:

To spark students interest and relate chemistry to society implement this lesson into unit on properties of matter.

Sewage Treatment

Objectives:

Through field trip, discussion and research, students learn how water and sewage are treated. Students will research the processes of wastewater treatment and how they relate to the breakdown of solid waste materials. This lesson will explore the applied mechanical, chemical, and biological process of wastewater treatment.

NY State Standards:

Chemistry St. 4, 3.1s: Mixtures are composed of two or more different substances that can be separated by physical means. When different substances are mixed together, a homogeneous or heterogeneous mixture is formed.

Materials:

Laptops with Internet access,

Procedures

Initiating:

Organize a field trip to your local water and/or wastewater treatment plant.

Transacting:

1.Explain wastewater treatment. (Process of removing pollutants from water previously used for municipal, industrial, and agricultural uses. The techniques used to remove the pollutants present in wastewater can be broken into biological, chemical, physical and energetic. Different techniques are applied through the many stages of wastewater treatment.)

2.Using computers with Internet access to have students' research and create visual presentation about: primary treatment, secondary treatment, and tertiary treatment.

Applying and expanding:

Have students' research and answer the questions below**.**

1. Who is responsible for making sure that wastewater is treated properly?

2. How do cities treat wastewater, to make it safe for discharge?

3. Are there any "natural" ways to treat wastewater?

Assessment opportunities:

Assess students understanding based on visual presentation, and respond to questions in applying and exploring section of the lesson.

Implementation Recommendation:

This lesson can be implemented into unit on physical behavior or matter.

Carbon Monoxide Poisoning

Objectives:

Students will be able to:

- Identify the characteristics and properties of gases.
- Compare properties of real and ideal gases.
- Understand the relationship among pressure, temperature, and volume of a constant amount of gas.
- Discuss the sources of carbon monoxide gas
- Understand the dangers of carbon monoxide (CO)
- Understand the importance of having and maintaining CO alarms in the home
- Know how to select the appropriate type of carbon monoxide alarm

NY State Standards:

Chemistry St. 4, 3.1kk the three phases of matter (solids, liquids, and gases) have different properties.

Chemistry St. 4, 3.4a: The concept of an ideal gas is a model to explain the behavior of gases. A real gas is most like an ideal gas when the real gas is at low pressure and high temperature.

Chemistry St. 4, 3.4b: Kinetic molecular theory (KMT) for an ideal gas states that all gas particles.

Chemistry St. 4, 3.4c: Kinetic molecular theory describes the relationships of pressure, volume, temperature, velocity, and frequency and force of collisions among gas molecules.

Chemistry St. 4, 3.4d:Collision theory states that a reaction is most likely to occur if reactant particles collide with the proper energy and orientation.

Chemistry St. 4, 3.4e: Equal volumes of gases at the same temperature and pressure contain an equal number of particles.

Materials:

125-mL Erlenmeyer flasks, balloons, Microwave oven, hot plate, ice bath,

Procedures

Initiating:

1. Have students read local story about CO poisoning.

Link:http://www.13wham.com/news/local/story/Gates-Police-Investigate-Carbon-Monoxide-Death/Y2sVBMukzEesuzlKdNRnPg.cspx

2. Ask students if they have seen or heard about carbon monoxide poisoning in community. Based on what they have heard, or from their own science knowledge, ask students to name three qualities of carbon monoxide.
3. Identify the key characteristics carbon monoxide.
4. Review properties and characteristics of gases, ideal gas law.

Transacting:

Put 5 ml of water into the Erlenmeyer flasks and stretch a balloon over the mouth of the flask. Heat the flask on hot plate until you see the water inside the flask boiling. Explain what cause the balloon to stretch. Next place the flask into ice bath. As the flask cools, the balloon is sucked into the flask. Explain the observation. Try to blow balloon into another flask. Explain why you were not able to blow the balloon into the flask.

Applying and expanding:

Have students explain:

1. What is produced when hydrocarbons burn completely in a plentiful supply of oxygen?
2. What is produced when incomplete combustion occurs due to insufficient oxygen?
3. When carbon monoxide is breathed in, what happens to the hemoglobin in red blood cells?
4. What happens to the brain if its supply of oxygen is reduced?
5. Identify potential sources of carbon monoxide in their daily lives.
6. The carbon monoxide is the leading cause of accidental poisoning deaths in the United States. Many states and local authorities require CO alarms be installed in residences. Check with your local building code official to find out about the requirements in your community. Create an informational brochure for residence of your community about the importance of CO alarms.

Assessment:

To assess students understanding collect students' informational brochures about CO alarms and answers to questions 1-5 from applying and exploring section of the lesson.

Implementation Recommendation:

Implement this lesson into unit on gases.

Heat of Combustion

Objective:

Students will be able to:

- Describe the basic chemistry of combustion.
- Define heat of combustion.

NY Standards:

Chemistry St. 4, 3.2b: Types of chemical reaction include synthesis (combustion), decomposition, single replacement, and double replacement.

Chemistry St. 4, 4.2d: energy released during chemical reaction (heat of reaction) is equal to the difference between the potential energy of the products and potential energy of reactants.

Materials:

Small soda can, a glass stirring rods, thermometer, graduated cylinder, ring stand, ring clasp, candle (paraffin wax $C_{25}H_{52}$), match

Procedures

Initiating:

1. Start with questions:
   - What is fire?
   - How important is fire to civilization?
   - Would civilization ever exist without fire? How would our life be different without the use of fire?
2. Explain combustion (fire) reaction (both complete and incomplete combustion) and the products of combustion reaction of hydrocarbons (heat, light, CO_2, and H_20)

3. Ask students to list examples of combustion used daily (natural gas water heater, stoves furnaces, gasoline powers cars).

4. Introduce energy conversions and state the law of conservation of energy.

5. Introduce specific heat capacity.

6. Define calorimeter and calorimetry.

Transacting:

In this activity students will measure the heat of combustion of candle and compare to heat of combustion of other hydrocarbons.

1. Weigh the candle to the nearest 0.01 g. Record your value.

2. Set up a ring stand with a ring clamp. Insert a glass rod through the holes in the small metal can. Suspend the can in the center of the ring clamp. Position the candle so that, when lit, the flame will not touch the bottom of the can. The bottom of the can should be 2 cm above the flame.

3. Using a graduated cylinder, measure exactly 200 mL of cold water and pour into your small metal can. The metal can, with water, will act as your calorimeter.

4. Stir the water with the thermometer and record the initial temperature of the water.

5. Light the candle.

6. Continue heating the water until the temperature reaches 35°C. Carefully blow out the candle. Continue to stir until the temperature stops rising. Record the highest temperature reached as the final temperature.

7. Return all equipment, and clean off your lab bench.

8. Weigh the candle. Record the final mass.

9. Calculate the mass of water heated.

10. Calculate the total rise in temperature of water.

11. Calculate how much thermal energy was used to heat the water.

12. Calculate the total mass of candle wax that was burned.

13. Calculate the molar heat of combustion of candle (paraffin wax $C_{25}H_{52}$)

14. Record all calculations in lab notebook.

15. Compare the molar heat of combustion of candle with the molar heat of combustion of other hydrocarbons. Explain the differences.

16. Which hydrocarbon is better fuel? Explain.

Applying and exploring

1. Welders and other construction workers use an extremely bright torch, mixture of acetylene and oxygen gas to produce oxyacetylene to weld or cut steel. Why is acetylene, rather than natural gas used in welding torches? Record your answer in lab notebook.
2. Describe how our life would be different without combustion reactions.
3. If I burn 0.315 moles of hexane (C_6H_{14}) in a bomb calorimeter containing 5.65 liters of water, what's the molar heat of combustion of hexane is the water temperature rises 55.40 ° C? The heat capacity of water is 4.184 J/g°C.
4. If I burn 22.0 grams of propane (C_3H_8) in a bomb calorimeter containing 3.25 liters of water, what's the molar heat of combustion of propane if the water temperature rises 29.50 °C?
5. Explain how bomb calorimetry works.

Assessment:

To assess students understandings collect the reports and answer to questions in applying and exploring section of the lesson.

Implementation recommendation:

Implement this lesson into unit on energy and chemical changes.

Chemistry Behind Hand Warmers

Objective:

Students should be able to:

- Explain how energy transfers are associated with chemical reactions
- Describe how exothermic reactions transfer energy to the surroundings
- Understand how energy released as heat from different metals is related to the metal's position in the reactivity series
- Apply chemistry learned in class to real life situation

NY Standards:

Chemistry St. 4, 4.1a: Energy can exist in different forms, such as chemical, electrical, electromagnetic, thermal, mechanical, nuclear.

Chemistry St. 4, 4.1b: Chemical and physical changes can be exothermic or endothermic.

Chemistry St. 4, 4.1c: Energy released or absorbed during a chemical reaction can be represented by a potential energy diagram.

Chemistry St. 4, 4.1d: Energy released or absorbed during a chemical reaction (heat of reaction) is equal to the difference between the potential energy of the products and potential energy of the reactant.

Materials:

Initiating: Reusable and disposable hand warmers,

Transecting: balance, iron powder, sodium chloride, sand, zipped log bag, water,

Applying and exploring: test tube, temperature probe, measuring cylinder, beaker, copper sulfate solution, iron powder, zinc powder, magnesium powder, copper powder, and aluminum powder.

Procedures

Initiating:

Pass out commercial reusable and disposable hand warmers.

Explain that oxidation of metals produces heat. (The faster the oxidation, the more heat is produced in a smaller amount of time.) Hand warmers produce heat from the oxidation of iron-to-iron oxide in the presence of water with sodium chloride as a catalyst.

Transacting:

In this activity you will make hand warmer to observe the heat energy that is given off during the oxidation of iron.

1. Weight 25 g of iron powder 1 g of sodium chloride. Place both iron powder and sodium chloride in a zipped log bag. Shake the bag to mix.
2. Next add 1 tablespoon of sand and shake well.
3. Add 5 ml of water and seal the bag. Shake it. The reaction should start after about minute.
4. Write balance equation of the reaction that occurred in your homemade hand-warming bag.

Applying and expending:

Design and carry out an investigation to find the best metal for hand warming bag.

1. Produce a testable hypothesis for the investigation. Write your own procedures and consider the variables, independent, dependent and control that you will need to manage during the investigation. Identify possible hazards.
2. Show me your hypothesis and procedures, for teacher approval.

3. Once you have teacher approval you may begin your investigation and record your results.
4. Analyze your own results, patterns in data and make a conclusion. Explain how the position of a metal in the reactivity series affects the heat produced when it reacts with copper sulfate solution.

Assessment:

To assess understanding collect investigation report (applying and exploring section of lesson)

Implementation recommendation:

Implement this lesson into unit plan about energy and chemical changes.

Can toothpaste slow down the teeth decaying?

Objectives:

Students will explore the rate of reaction. Students will use solubility product calculation to explore the effectiveness of fluoride in preventing tooth decay.

NY State Standards:

Chemistry St. 4, 3.4i: At equilibrium the rate of the forward reaction equals the rate of the reverse reaction. The measurable quantities of reactants and products remain constant at equilibrium.

Chemistry St. 4, 3.4h: Some chemical and physical changes can reach equilibrium.

Chemistry St. 4, 3.2b: Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement.

Materials:

Chicken eggshells, 3 to 5 different brands of toothpaste (Colgate, Crest, Oral-B, Pronamel, Sensodyne), test tubes and Erlenmeyer flasks, oven, electronic balance, filter paper, 4M HCl, distill water, pressure probe.

Procedures

Initiating:

Start by discussing the importance of dental care.

Ask students which brand of toothpaste they prefer?

Ask students what the commercial claim about toothpaste. (Commercials claim that toothpaste remove plague and prevent cavities for up to 24 hours)

Ask what cause tooth decay?

Explain how fluoride ions prevent tooth decay.

Explain how to determine equilibrium concentration of reactants and products.

Demonstrate how to calculate the solubility of compound from its solubility product constant.

Explain the common ion effect.

Transacting:

To prevent tooth decay many types of toothpaste contain fluoride, which react with hydroxyapatite in tooth enamel to form a fluorophosphates ($Ca_5(PO_4)_3$) also known as fluorapatite. Fluorapatite adheres tightly to the hydroxyapatite in the enamel, making tooth enamel more resistant to attack from acid that are produce when bacterial in mouth react with certain food. In this experiment we will investigate which toothpaste can most effectively slow down the rate of reaction between tooth enamel and acid (tooth decay process). Since approximately 94 % of dry eggshell is calcium carbonate, we will use chicken eggshells to substitute for human teeth.

1. Dissolve 4g of toothpaste in 50ml of distilled water.
2. Put 4 g of eggshells into the prepare solution.
3. Make sure that the eggshells are crushed into find powder.
4. Repeat step 1-2 for all remaining toothpaste brands (label each beaker with the name of selected toothpaste.
5. Set the solution a side for day. Layer of $Ca_5(PO_4)_3F$ will form on eggshells.
6. Next day filter the eggshell and dry them in oven.
7. Take about 1g of dry eggshells and put them into a flask with 50 ml of 4M HCl acid, connect pressure sensor to the flask.
8. Once all of $Ca_5(PO_4)_3F$ reacted, HCl will start to react with the eggshell($CaCO_3$)

and CO_2 will start forming.

9. The pressure probe will measure the pressure of CO_2 formed.
10. Record measurement.
11. Compare graphs of all toothpaste samples in labQuest,
12. Which toothpaste has the lower initial rate and highest ability to prevent tooth decay?

Application and Exploring

Enamel, the thin and hard outer covering of the tooth is 98% of hydroxyapatite ($Ca_5(PO_4)_3OH$). This tough shell is the hardest tissue in the human body. Although hydroxyapatite is insoluble in water, demineralization of hydroxyapatite does occur when saliva contain acids. The reverse reaction remineralization (redepositing of tooth enamel) occurs when hydroxyapatite is in solution with fluoride ions. Double replacement reaction occurs, fluoride ions replace the hydroxide ions to form flouoroaptite ($Ca_5(PO_4)_3F$, chemical name calcium fluorophosphate). Flouoroaptite re-mineralizes the tooth enamel and partially displaces hydroxyapatite. The destructive demineralization of enamel is reduces because flouoroapatite is less soluble than hydroxyapatite.

1. Write equation that describes the double replacement reaction that occurs between hydroxyapatite and sodium fluoride.
2. Calculate the solubility of hydroxyapatite and flouoroapatite in water, and compare the solubility.

Assessment:

To access students understanding collect toothpaste experiment report, and answer to questions 1 and 2 in the applying and exploring section.

Implementation recommendation:

This lesson can be easy implemented into unit on chemical equilibrium.

Cleaning up an Oil Spill

Objectives:

- Students will conduct an experiment to determine the contributing factors to the solubility of a system.
- Students will be able to explain the role of polarity in the solubility of a system
- Students will be able to evaluate some physical and chemical techniques use to clean up an oil spill

NY State Standards:

Chemistry St. 4, 3.1gg Hydrocarbons are compounds that contain only carbon and hydrogen. Saturated hydrocarbons contain only single carbon-carbon bonds. Unsaturated hydrocarbons contain at least one multiple carbon-carbon bond.

Chemistry St. 4, 5.2n Physical properties of substance can be explain in terms of chemical bonds and intermolecular forces. These properties include conductivity, malleability, solubility, hardness, melting point, and boiling point.

Materials:

Water, pipette, car oil, plastic bucket, syringe, oil absorbing polymer, loose wool, wool blanket, boom materials, cellulose

Procedures:

Initiating

Ask students if they have ever noticed a rainbow puddle on the street or parking lot after a rain? The rainbow gloss that you see on top of the water is actually oil from cars that have leaked onto the ground. Have you ever considered the difficulty involved in cleaning an oil spill?

Recall 2010 Gulf of Mexico oil spill. Have students generate information about the oil spill in Gulf of Mexico. Discuss the oil spill and different methods of cleaning up oil spills (bioremediation, controlled burning, dispersants, solidifying, dredging, skimming). Demo: Pour 300ml of water in to beaker A, and add 100 ml of cooking oil. Pour 300ml of water in to beaker B, and add 100 ml of ethanol. Compare both solutions. Ask students: Is water an organic or an inorganic molecule? Is water polar or nonpolar? Is oil polar or nonpolar? Did the oil dissolve in water? What kind of solvent is needed to dissolve a polar compound? This demo clearly shows that water is denser than oil. Oil float and spreads rapidly on water's surface.

Transacting:

Based on the clean up methods discussed at the beginning at the class, your task is to try as many cleanup methods as possible to clean up the oil in the set up above. Observe, record the results and calculate the absorbency ratio of each product used.

Applying and expanding:

1. Explain how the oil behaved as you tried to clean it up.
2. Was the oil easy to remove from the water? Explain?
3. Which material was the most effective?
4. Which material was the easiest to use?
5. Is it better to use more than one method to clean up the oil spill?
6. Which material do you think is most expensive? Explain?
7. Which material do you think is the least expensive? Explain your answer?
8. Which materials might be hazardous to the environment? Explain your answer?
9. What is the impact of oil spills on animals?

10. As scientist, what materials would you recommend using to clean up oils spill in your community (consider type of oil spill water/ground, the effectiveness, the cost, effect on environment, and the ease of use).

Assessment:

Students should be able to:

- Explain an oil spill in terms of density of a liquid.
- Demonstrate different methods of cleaning up oil spills.
- Relate oil spills to an environmental damage.

Implementation recommendation:

Implement this into unit on organic chemistry or mixtures and solutions.

Batteries

Objective:

By the end of the lesson, students will be able to:

- Describe the structure composition, and operation of the typical carbon-zinc dry cell batteries.
- Distinguish between primary and secondary batteries.
- Apply chemistry learn in class to daily life.

NY State Standards

Chemistry St. 4, 3.2 k: A voltaic cell spontaneously converts chemical energy to electrical energy.

Chemistry St. 4, 3.2, vii: Identify and label the parts of a voltaic cell (cathode, anode, salt bridge) and direction of electron flow, given the reaction equation.

Chemistry St. 7, 1.1 Analyze science/technology/ society problems and issues on a community, national, or global scale and plan and carry out remedial course of action.

- Carry out a remedial course of action by communicating the plan to others, e.g., writing and sending "a letter to the editor"

Materials:

Variety of batteries, laptops with Internet access,

Procedures

Initiating:

1. Bring a variety of different batteries to class (rechargeable and non-rechargeable)

Ask students:

- What battery operated devices do you use on a typical day?

- What occur when battery is used up?
- Why batteries have positive and negative pole?

2. Post on smart board diagram of battery, and describe the structure, composition and operation of the typical carbon zinc dry cell battery.

3. Distinguish between primary and secondary batteries.

Transacting:

Batteries disposal is becoming a serious environmental problem. According to RMC, approximately 200,000 tons of batteries are landfilled in North America each year. Disposal of nickel-cadmium and lead- acid batteries raises many concerns because of the toxicity of nickel, cadmium and lead. When these batteries are placed in landfills, toxic substances may contaminate ground water and pose a thread to humans.

On May 13, 1996, President Bill Clinton, signed into law act which states that all Nickel-Cadmium and Sealed Lead batteries must have the chasing arrows logo or similar recycling symbols and a phrase that says the "battery must be recycled or disposed" through regulated battery collection programs. It also phases out the use of mercury in nearly all batteries. Grab a laptop and go to EPA, United State Environmental Protection Agency web site. Read "Implementation of the mercury- containing and rechargeable battery management Act".

Link: http://www.epa.gov/osw/hazard/recycling/battery.pdf

Once you finish reading in your lab notebook answer the following questions:

1. Why proper disposal or recycling is necessary for Ni-Cd and SSLA batteries?
2. What can you do to keep a battery working for a longer period of time?

3. In two paragraphs discuss the environmental impact of the use of metals such as lead, mercury and cadmium in the consumer products of today's society.

Applying and Exploring:

Create informational booklet for members of your community about batteries disposal**.**

The booklet must include:

- Summery of Battery Management Act.
- Summery of state and federal requirements affecting battery recycling prior to passage of the Battery Act.
- Why proper disposal or recycling of batteries is necessary?
- What are some problems with using batteries?
- Suggest what we as community could do to decrease the production of hazardous waste.

Assessment opportunities:

To assess understanding collect informational booklet and respond to question 1-3 in transacting section.

Implementation recommendation:

Implement this lesson into unit on redox and electrochemistry

Electrolysis

Objective:

By the end of the lesson, students will be able to:

- Apply chemistry learn in class to real life situation
- Describe electrolysis mechanism
- Explain the various useful applications of electrolysis: electroplating
- Emphasize the importance of the composition of the electrodes in the electroplating apparatus
- Write the equations of the reaction that take place at electrodes

NY State Standard:

Chemistry St. 4, 3.2j: Electrochemical cells can be either voltaic or electrolytic. In electrochemical cell the oxidation occurs at the anode and the reduction occurs at cathode.

Chemistry St. 4, 3.2d: An oxidation-reduction (redox) reaction involves the transfer of electrons (e-).

Chemistry St. 4, 3.2e: Reduction is the gain of electrons.

Chemistry St. 4, 3.2f: A half-reaction can be written to represent reduction.

Chemistry St. 4, 3.2g: Oxidation is the loss of electrons.

Chemistry St. 4, 3.2h: A half-reaction can be written to represent oxidation.

Chemistry St. 4, 3.2i: Oxidation numbers (states) can be assigned to atoms and ions. Changes in oxidation numbers indicate that oxidation and reduction have occurred.

Materials:

Jewelry/silverware that has electroplating that has worn off, piece of copper with a hole (round or square), bare copper wire, zinc metal strip, two wire leads with clips, 1 M zinc nitrate ($Zn(CO_3)_2$), battery, masking tape, steel wool, razor knife, clear nail polish, rubbing alcohol.

Procedures

Initiating:

1. To grab students' attention, at the beginning of class pass out a piece of jewelry or silverware that has electroplating that has worn off. Show students what happened to the original metal under the electroplating. The metal may be a greenish color and may even leave green on their hands when they touch it or wear it.
2. Explain electrolysis, and describe how is it possible to reverse a spontaneous redox reaction in an electrochemical cell.
3. Compare the reactions involved in the electrolysis of molten sodium chloride with those in the electrolysis.
4. Discuss the importance of electrolysis in the smelting and purifying metals.
5. Review redox reaction (Reduction, oxidation, half reaction, and oxidation numbers).

Transacting:

You are going to perform a simplified form of electroplating; to make zinc plated jewelry or an ornament. Once you finish this activity you will become familiar with the electroplating first hand.

1. Polish the copper with steel wool.

2. Cover the copper with masking tape and cut out desired design with razor knife and clean with rubbing alcohol. Let it dry.
3. Push the copper wire through the hole in the copper object. (The copper wire must make contact with the bare copper object).
4. Fill beaker with zinc nitrate solution. Using the wire lead with clips connect one wire between the negative terminal to of the battery to and the copper wire attached to your copper object. Connect the second wire between the positive terminal and zinc strip. Inserts zinc strip and your copper object into zinc nitrate solution. Make sure that your copper object do not touch zinc strip.
5. After few minutes remove your copper object from the solution. Disconnect the wires and wash the object with water. Remove the masking tape, be careful very thin layer of zinc is plated on the copper and can be easily rub rubbed off. To protect your freshly plated object from rubbing off paint it with clear nail polish.

In your lab notebook describe:

1. The process in terms of oxidation-reduction reaction.
2. Write the equations of the reaction that take place at electrodes.
3. Draw diagram of the electrolytic cell used.
4. Explain why it is important that the copper object be clean before electroplating.
5. Explain what would have happened if the connections from battery were reversed.

6. What do you think happens to the cathode and anode over time as electroplating takes time?

Applying and Exploring:

1. Research industrial uses of electroplating and the importance of electrolysis in the smelting and purifying metals. Report your findings in your lab notebook.

Assessment opportunities:

To assess students' understanding collect lab notebooks and read students responds to questions 1-6 from transacting and question 1 from applying and exploring section.

Implementation recommendation:

Implement this lesson into unit on redox reactions and electrochemistry

Polymer Recycling

Objectives:

Students willable to:

- Explain the composition of polymers and give several examples of polymers
- Understand polymerization reaction
- Differentiate and identify materials as synthetic or natural polymers.
- Examine and observe characteristics of different materials that are polymers.

NY State Standards:

Chemistry St 4, 3.2c: Types of organic reactions include addition, substitution, polymerization, esterification, saponification, and combustion.

Procedures

Initiating:

Point out to students that it is difficult to look around without encountering or seeing something made of synthetic polymers. Polymers are an integral part of life in industrialized countries and it is difficult to find an aspect of our lives that is not affected by synthetic polymers. Materials we now take for granted such as plastic sandwich bags, foam cups, nylon and polyester fabric, Teflon and a variety of other synthetic materials were non-existent just a century ago. Before development of synthetic polymers people were limited to natural products such as cotton, wood, stone and metals. Synthetic polymers have many applications due to their different properties. Polymers may be hard or soft, flexible or rigid, elastic or inelastic, heat resistant or heat conductive, waterproof or water soluble, electrically insolated or electrically conductive. The use of synthetic polymers have caused some problems, too. Many of the disadvantages of using plastics come from the same properties that make them so useful. It is often cheaper to throw away plastic materials and make new once than it is to reuse them. As a result, plastics increase the value of trash, and unfortunately they don't break down into simpler materials in the environment in the same way as the natural polymers. In order to reduce the demand for landfill space and the consumption of limited petroleum reserves, the recycling of polymers has become a subject of concern. Disposal of non-biodegradable polymers presents a serious problem to our environment. Discarded plastics may take as long as fifty years to disintegrate. Each year millions of tons of plastics are buried in landfills or dumped into the oceans. Unfortunately, polymers cannot be buried in sanitary landfills or burned in populated areas because poisonous gases are produced when they burn. Floating plastics dumped in water are a major hazard for marine creatures. (Since we live in the age of polymers, students should be able to identify different types of polymers, their properties, applications, and they should know how to recycle and reuse polymers.)

Transacting:

Polymer Recycling

1. The plastic industry has adopted a coding system to help recyclers identify types of plastics. A triangular symbol with a number is molded or imprinted on the bottom of most plastic containers. The number indicates the type of polymer the product is made off. There are seven different kinds of recyclable plastics. Each of the seven types of plastics can be reused in some way. Look around your homes and record in the table below polymers that you encounter in your daily life, their properties and ways of reusing them.

2. Find out how plastic is recycled in your community. What are plastic recycling guidelines and general recycling rules in your community? All of the seven types of plastics are recyclable; unfortunately not all recycling programs will accept all types of plastic. Compare two local recycling programs (garbage collections companies: Boon & Sons, Waste Management, Suburban Disposal). Present your findings to the class in a short PowerPoint presentation or poster.

Recycling Symbol	**Name of Polymer**	**Type of polymerization reaction**	**Sample Uses**	**Characteristics and potential salvage**
1 PETE				
2 HDPE				
3 V				
5 PP				
6 PS				
7 OTHER				

Applying and Exploring:

1. List five benefits of recycling.
2. Describe some of the uses of synthetic polymers in your life. Then describe what changes you would have to make in your lifestyle if these polymers were not available.

Assessment:

In order to assess student understanding watch their presentations and collect their responses to questions. Have students choose one synthetic polymer and describe how it has made a difference in their lives in a short presentation (power point, oral, or poster)

Recommendations for implementation:

Implement this lesson into unit on organic chemistry.

Identifying Unknown Plastic Types

Objectives:

Students will be able to explain the concepts governing the recycling of plastics, problems encountered in the recycling process due to the different types of plastics used. Predict polymer properties based on their molecular structure and the presence of a special functional group. Students will gain an understanding of the differing properties of each type of plastic using density to illustrate the concept.

NY State Standards:

Chemistry St 4, 3.1dd: Compound can be differentiated by their physical and chemical properties.

Chemistry St 4, 3.1ff: Organic compounds contain carbon atoms, which bond to one another in chains, rings, and networks to form a variety of structures. Organic compounds can be named using the IUPAC system.

Chemistry St 4, 3.1hh Organic acids, alcohols, esters, aldehydes, ketones, ethers, halides, amines, amides, and amino acids are categories of organic compounds that differ in their structures. Functional groups impart distinctive physical and chemical properties to organic compounds.

Chemistry St 4, 3.2c:Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion.

Materials:

Samples of unknown plastics, four 500-ml beakers, paper towels, tongs, reference table with densities of common plastics

Densities of common plastics

Symbol	Name	Density g/ml
1 PETE	POLYETHYLENE TEREPHTHALATE	**1.38- 1.39**
2 HDPE	HIGH DENSITY POLYETHYLENE	**0.96- 0.97**
3 V	POLYVINYL CHLORIDE	**1.16-1.35**
4 LDPE	LOW DENSITY POLYETHYLENE	**0.92-0.94**
5 PP	POLYPROPYLENE	**0.90-0.91**
6 PS	POLYSTYRENE	**1.05- 1.07**

Procedures

Initiating:

Start class with video.

Link http://www.youtube.com/watch?v=8l09XgK9Ux8&feature=fvwrel

- Discuss the general polymer chemistry.
- Discuss and distinguish differences between physical and chemical properties.
- Explain the differing properties of the six types of recyclable plastics and association with a triangular symbol/number.
- Discuss the wide range of products made from recycled plastics.

Transacting:

In this activity students will test an unknown plastic sample in order to determine what type of plastic the sample represents through the use of a density.

1. Label the four beakers as fallows:

   #1(0.90 g/ml), #2 (1.05 g/ml), #3(1.16 g/ml), #4 (1.38 g/ml)

2. Place 300ml of (0.90g/ml solution) to beaker #1. (To save time all of the four solutions are premade by teacher)
3. Place 300 ml of (1.05 g/ml solution) to beaker #2.
4. Place 300ml of (1.16g/ml solution) to beaker #3.
5. Place 300ml of (1.38 g/ml solution) to beaker # 4.
6. With the tongs place the first sample into beaker #1, and submerge the sample in the solution. Observe whether it sinks or floats. Record observation in table 1. Remove the sample form solution, rinse in water, and dry with paper towel. Test the sample in remaining beakers #2, #3 and #4.
7. Repeat step 6 for the remaining 3 samples.

Table 1: Indicate whether the sample sink or float in each solution

Sample Number	Solution 1 (0.90 g/ml)	Solution 2 (1.05 g/ml)	Solution 3 (1.16 g/ml)	Solution 4 (1.38 g/ml)
1				
2				
3				
4				

Table 2: Use observations and density chart to determine the name of each plastic sample.

Sample Number	Density	Name of Plastic
1		
2		
3		
4		

Applying and Exploring:

Write a letter to local authorities that address the significance of recycling and waste separation. Explain; why sorting and separating discarded plastics helps make recycling more effective.

Assessment:

To assess students understanding collect

- Unknown polymer identification activity
- Letter to local authorities

Recommendations for implementation:

This activity can be easy implemented when discussing properties and changes of matter or when introducing organic chemistry (polymerization).

Properties of Natural vs. Synthetic Polymers

Objective:

Students will be able to:

- Explain the relationship between polymer and the monomer from which it forms.
- Classify polymerization reaction as addition or condensation.
- Compare properties of natural and synthetic polymers (strength, resistance to chemical damage, and absorbency).
- Predict polymer properties based on their molecular structure and the presence of a specific functional group.

NY State Standards:

Chemistry St. 4, 3.1dd: Compounds can be differentiated by their physical and chemical properties.

Chemistry St. 4, 3.1ff: Organic compounds contain carbon atoms, which bond to one another in chains, rings, and networks to form a variety of structures. Organic compounds can be named using the IUPAC system.

Chemistry St. 4, 3.1gg: Hydrocarbons are compounds that contain only carbon and hydrogen. Saturated hydrocarbons contain only single carbon-carbon bonds. Unsaturated hydrocarbons contain at least one multiple carbon-carbon bond.

Chemistry St. 4, 3.2c Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion.

Materials:

4 samples of natural polymer cloth: cotton, linen, silk, and wool

4 samples of synthetic polymer cloth: acetate, nylon, polyester, and rayon

16 Styrofoam cups, vinegar, bleach, water

Procedures

Initiating:

Lead class discussion about properties of polymers. Show students several objects made from polymers and ask students what they know about each polymer and to explain why it is used to make that object. Ask students what other materials could be used to make those polymers.

Ask students to list specific advantages of using synthetic polymers composites in sports equipment such as bicycles, skies, baseball bats, and tennis racquets. For example, ask: What advantage does racer have riding light weight bicycle?

Explain the composition of polymers and polymerization reaction.

Transacting:

In this activity you will compare properties and strength of natural and synthetic polymers. Fallow the steps below to complete the activity.

1. Record the color of each cloth.
2. Label 8 cups bleach plus the name of each cloth samples.
3. Cut a small piece from each cloth, place in its cup and pour bleach into each cup.
4. Label the remaining 8 cups vinegar plus the name of each cloth sample. Place the cloth samples in it cup and pour vinegar.
5. Set the cups a side for at least one day.
6. Using the remaining samples of cloth try to rip each fabric. Record observations.
7. Place a drop of water on each fabric. Record if the sample absorbed or repelled water.

8. On the next day, pour the bleach and vinegar out of the cups into sink. Dry samples and record color changes.

Analysis and applications:

Answer all questions in lab notebook

1. Compare nature and synthetic polymers strength, absorbency and resistance to chemical damage. Which fabric held its color best in bleach or vinegar (acid)? Which were least resistant to chemical damage? Which fabric has the stronger fibers and was hardest to rip?
2. Investigate few different types of polyester. How are they form and explain their difference in properties?
3. List at least five everyday products made of polyester and compare them to natural polymers.

Assessment:

1. Have students identify characteristic that both synthetic and natural polymers share.
2. Collect lab notebooks and use students' respond to question for assessment.

Recommendations for implementation:

This activity can be easy implemented in to unit on organic chemistry.

Rusty Nail #1

Objectives:

Students will observe redox reaction and describe the process of oxidation and reduction. Students will identify oxidizing and reducing agents, and determine the oxidation number. Students will understand that every chemical reaction requires activation energy to get started and list factors that control the rate of reaction.

NY State Standards:

Chemistry St. 4, 3.3a: In all chemical reactions there is a conservation of mass, energy, and charge.

Chemistry St. 4, 3.3b: In a redox reaction the number of electrons lost is equal to the number of electrons gained.

Chemistry St. 4, 3.4f: The rate of a chemical reaction depends on several factors: temperature, concentration, nature of the reactants, surface area, and the presence of a catalyst.

Material:

Test tube rack, four test tube, 4 iron nails, 1 rubber plug, deionized water, cooking oil, calcium chloride granule, table salt.

Procedure

Initiating:

- Ask students to explain why meat or milk is kept cool. Does food ever spoil in the refrigerator?
- Explain how energy is related to chemical reaction (activation energy)
- Explain what effects rate of reaction and factors that control rate of reaction.

- Review types of chemical reaction.

Transacting:

Rusty nail 1 is a simple controlled experiment that investigates the conditions needed for rusting to occur. It shows that iron rust when it comes into contact with moisture. Once the causes of corrosion are known we can introduce methods used to prevent it.

1. Place a clean iron nail into test tube # 1 and add deionized water.
2. Place a clean iron nail into test tube # 2 add water that has been boiled for 15 minutes to remove the dissolved oxygen and cover the water with cooking oil.
3. Place a clean nail into test tube # 3 and add solution of deionized water mixed with table salt.
4. Place calcium chloride granulates in to test tube # 4, add a clean nail and cover the test tube with rubber plug.
5. Set the test tubes aside for at least three days and then observed what happened in each test tube.
6. In lab notebook record all tested conditions.
7. Identify substance formed on the nail.
8. Write balance chemical equation for the reaction you observed.
9. Write a conclusion to this lab exercise.

Applying and expending:

1. Ask students what would happen if the copper was placed in an iron sulfate solution.
2. Have students develop an analogy that illustrates oxidation, reduction, oxidizing agent, and reducing agent.

Assessment:

1. To assess understanding collect analogies developed by students that illustrates oxidation, reduction, oxidizing and reducing agents.
2. Ask students to name at least three ways to control chemical reactions.

Implementation recommendations:

Implement this activity into unit on redox chemistry or rate of reaction.

Rusty nail #2

Objective:

Students will be able to:

- Identify and observe chemical reactions and changes in daily life and record evidence of those changes.
- Classify types of chemical reactions
- Describe the processes of oxidation and reduction.
- Identify oxidizing and reducing agents.

NY State Standards:

Chemistry St. 4, 3.2b: Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement.

Chemistry St. 4, 3.2d: An oxidation-reduction (redox) reaction involves the transfer of electrons (e-).

Chemistry St. 4, 3.2e: Reduction is the gain of electrons.

Chemistry St. 4, 3.2f: A half-reaction can be written to represent reduction.

Chemistry St. 4, 3.2g: Oxidation is the loss of electrons.

Chemistry St. 4, 3.2h: A half-reaction can be written to represent oxidation.

Chemistry St. 4, 3.3a: In all chemical reactions there is a conservation of mass, energy, and charge.

Chemistry St. 4, 3.3b: In a redox reaction the number of electrons lost is equal to the number of electrons gained.

Chemistry St. 4, 3.4f:The rate of a chemical reaction depends on several factors: temperature, concentration, nature of the reactants, surface area, and the presence of a catalyst.

Material:

4 well Petri dish, 3 iron nails, 1 galvanized nail, magnesium ribbon copper wire, dilute hydrochloric acid, placemat (Appendix A)

Procedure

Initiating:

Start with discussion: many students think that that chemistry only happens in lab. Point out that many chemical reactions occur around them and are important part of their lives. The green color of the Statue of Liberty or rust coating on the surface of once silver fence are example of chemical changes. Using an interactive white board, post pictures of rusted object and start discussion. (Everyone has seen metal object covered with rust. Rusting is a commonly occurring process with which we are all familiar and something that we try to avoid). Talk about iron treatments designed to prevent rusting such as paints, coatings and alloys. Explain that those methods all have industrial applications and are tested in research facilities. Principles behind them can be tested in chemistry class.

Transacting:

This lab will introduces and permits students to observe the effectiveness of various methods of rust prevention.

1. Place one 4-well Petri dish on placemat
2. Sand three iron nails.

3. Place one sanded iron nail in well 1
4. Place one galvanized nail (zinc coated iron) into well 2
5. Wrap one iron nail with a magnesium ribbon and place into well 3
6. Wrap one iron nail with a copper wire and place into well 4
7. Cover all nails with a dilute hydrochloric acid solution and leave them in the solution for 24 hours.
8. Construct a table to record your predictions determined regarding which metal will protect the iron nail from corroding, and which metal will make the iron nail corrode faster.
9. Construct a table to record your observations regarding which metal will protect the iron nail from corroding, and which metal will make the iron nail corrode faster.
10. Write three errors related to this lab procedure.
11. Write a conclusion to this lab exercise

Applying and exploring:

1) Write three commercial or practical applications that would apply what you learned in this lab. How do these improve our daily life? Explain your answer.

Assessment:

To assess students understanding collect lab write and answer to question 1 from applying and exploring section of the lesson.

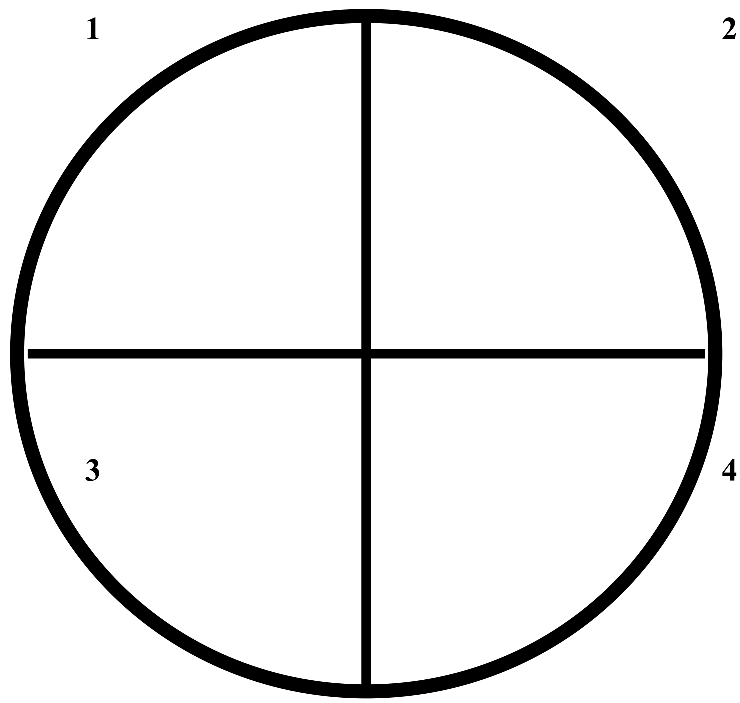
Implementations Recommendation:

Implement this activity into unit on redox reaction.

Placemat

Bare iron nail

Galvanized nail (zinc coated)



Magnesium wrapped
Iron nail

Copper wrapped
Iron nail

strongly supports implementation of context based learning and classroom technology use in order to enhance science education. Context based science instruction fosters active learning, positive peer interaction and attitude toward science, and it encourages creativity, curiosity and promotes a stronger sense of ownership. Students taught with STS approach show significant progress in problem solving and critical thinking related to science, recognize the importance of science in daily life and apply science knowledge into new situation (Yager, 1993; Winther & Volk, 1994). STS allows students to build on their current knowledge, relate new concepts to issues they encountered previously in their daily life or school, and promote interaction between the curriculum and the students' experience. Selection of context is also a very important condition for successful context-based science teaching. Content should not be too complicated or confusing for students. It should be well known and relevant for both boys and girls.

Inquiry-based science education and technology offers tremendous potential for the enhancement of the teaching and learning of science concept, but there has been little comparison to traditional science instruction. Most of studies about content based science approaches focuses on student motivation and attitude about science, therefore further studies and qualitative research is necessary and should be conducted to determine whether context- based learning is effective in raising science achievement and scores on standardized test.

In conclusion, decreasing enrolment in science courses and science related fields, especially chemistry is caused by difficulty of content and lack of interest in science. This project is a collection of context-based activities and laboratories, which aim to enhance and stimulate students' interest and involvement in science by relating new science concepts to students' preexisting networks of ideals that students encounter in daily life. Each activity or laboratory is not only directly link and include New York State Chemistry standards, list objective, materials, procedures, suggest assessment and implementation recommendation but, also strongly relate to life out side of classroom. All lessons in the project are design to make learning meaningful and to help students connect science content learn in the classroom to real life situation, society, health, technology, and environment. In addition, each activity or laboratory allows students to make judgment and decision about positive and negative aspects of science and technology on society, health and environment.

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