WHAT ARE THE EFFECTS OF SCIENCE OUTREACH BY COLLEGE STUDENTS WITH ELEMENTARY SCHOOL CHILDREN?

by

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In presenting this professional paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the MSSE Program shall make it available to borrowers under rules of the program.

JoDean Lynn Knutson-Person

July 2011

DEDICATION

To my amazing husband Mark,

My handsome young man Noah, My beautiful daughter Anna,

My loving parents and sister, Gary, Marti, Billi Jo…

Families are of an eternal design.

As each member grows and progresses you'll find,

That working together is essential,

For each member to reach his or her potential.

~author unknown

Thanks for helping me stretch to reach mine!

Love,

JoDe - JoDz – Mom – Auntie Jo

To Noah and Anna, I have watched you grow into fine young people and expect you to have great hope for your future. I love you and am very proud of you.

To my husband, Mark, whose endless love, support and encouragement cannot even begin to be expressed in this space… thank you!

To my family and friends, thanks for your patience and understanding as I went down this pathway. Your continued love and support to me and my family made this project feasible. Thanks for sticking with me and lending a shoulder and an ear when needed.

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ABSTRACT

This project focused on developing a service learning group of college students to do science outreach with elementary students as a win-win opportunity to increase the content knowledge of all the students involved, give the college students the opportunity to empower the elementary students, and fulfill some of the needs of the college awareness program at an elementary school.

Analysis of this project was completed using results from pre- and post-outreach experience questionnaires as a way to establish demographic information of the participants, get comparative awareness and interest of college and science information, and find some common points to make connections between the groups of students. Questionnaires were also used for the classroom teachers to understand how outreach benefited their classroom. Journals were utilized with college students as well as wrap-up meetings after each outreach experience in order to document personal experiences both as a mentor as well as students growing in their own content mastery. I also kept notes of the experience from my viewpoint.

INTRODUCTION AND BACKGROUND

Project Background

Two years ago, the Jeannette Myhre Elementary fifth and sixth graders in Bismarck, North Dakota participated in The Gallup Student Poll which measures the hope, well-being, and engagement of America's youth. Results of this showed less than half (48%) of their students felt hope for their future, while the national statistics showed 53% of students felt hope for their future (Gallup, 2010, p. 4). When the principal saw these results, she called in the counselor and they went into action. Part of this action was developing a program within their school which they call "Hope for the Future." This program aims to increase their students' college readiness and awareness. During the 2009-2010 and current school year, Myhre called on the local technical schools, colleges, and universities to participate in school-wide assemblies as well as classroom activities.

I have been a full-time chemistry instructor at Bismarck State College since the spring of 2009. Prior to that, I was the chemistry stockroom coordinator and adjunct instructor since the fall of 2000. I have always been concerned about the large percentage of underprepared students at our campus and have worked especially hard to help those students succeed in my course. Upon hearing of the call for action from Myhre, I decided to do my capstone project on developing an outreach group of science students to do a service learning project with two classes of Myhre Elementary as a win-win opportunity to reinforce the science content knowledge of all of the students involved, give the college students the opportunity to empower the students of Myhre, and fulfill some of the needs of the "Hope for the Future" program.

As another incentive or "sign" for this project, during our state of the campus address in October, 2010, our college president shared the BSC Strategic Plan (2010-2012) which includes one objective "to enhance services and quality instruction that [will] improve and enhance our service learning program in a way that integrates service with the college curriculum." Reaching even beyond our campus to the North Dakota University System, the president also shared the *2009-2013 NDUS Strategic Plan and Objectives* which include three specific focus areas revolving around improving college preparedness, promoting college awareness, and extending college outreach to those underrepresented students. These points of interest really reinforced my idea that now was the time for an outreach project involving service learning.

The focus of this project explored the effects of an outreach service learning project with Bismarck State College science students and elementary school children of Jeannette Myhre Elementary School, population 297 of the 10,775 public school students of Bismarck, the capitol city of North Dakota having a population of 106,289 in 2009 (Bismarck Public Schools, About Us, 2010). Of these students, 73% of them receive free or reduced meals. Minority students make up 28.2% of the population (Myhre, About Our School, 2009).

Bismarck State College (BSC) is a two-year, open-enrollment community college with 4,177 students in the fall of 2010 (About BSC, 2010). The diversity of students is not so much in ethnicity (87.4% Caucasian, 2.3% American Indian), but in age (26.6% 18-19, 18.8% 20-21, 12.1% 22-24, 12.8% 25-29, 14% 30-40, 15.7% other), life situation and educational background.

The focus question for this project was, “What are the effects of science outreach by college students with elementary school students?” The sub-questions included the following:

- ✓ How does a science outreach project empower the college student?
- ✓ How does a science outreach project empower the elementary student to have a hopeful future which includes college aspirations?

The results of this study will be used to develop a template for service learning for the campus as well as building further collaborations with additional area elementary schools.

CONCEPTUAL FRAMEWORK

Outreach in education is defined “a meaningful and mutually beneficial collaboration with partners… [it includes] that aspect of teaching that enables learning beyond the campus walls…of research that makes what we discover useful beyond the academic community… of service that directly benefits the public” (The Ohio State University, 2010). One form of outreach is service learning. Service learning is defined as “a form of experiential education characterized by students participation in an organized service activity that: is connected to specific learning outcomes; meets identified community needs; and provides structured time for student reflection and connection of the service experience to learning" (The Ohio State University, 2010). Service learning projects in education include activities like tutoring and mentoring other students, volunteering as a science museum guide, helping to refine chemical processes for surface treatment of copper for a chemistry in art course, and nursing students volunteering in a senior center or hospital. Opportunities such as these help the student develop connections beyond the classroom, "expand the size of their bubble," and see how volunteering ones services can connect with their career goals (The Ohio State University, 2010).

Key elements to service learning include: (1) appropriate liberal education and major/professional knowledge for the students, (2) students must go off campus to experience the outreach in the community, (3) a relationship must be formed where students, faculty, and the community are partners with a common goal, (4) an empowering experience for the students as well as those they are working with, (5) all around support not only financially but technologically as well as allowing time for the faculty to organize the outreach experience, (6) a unique experience only found between the institution and community it serves (Altman, 1996).

Outreach can promote a more positive perception of chemistry and science in general (LaRiviere, Miller, & Millard, 2007). It can also serve to enhance the educational experience of college students and inspire them to empower elementary school children to have hopes for the future, which would include a college education (Altman, 1996). By being involved in outreach, it has been seen that students further develop their knowledge based on active participation in organized experiences in the real-world that meet the needs of the community and are coordinated with a formal educational institution (Andrews, Weaver, Hanley, Shamatha, & Melton, 2005).

Ways to reinforce learning during an outreach experience include keeping a notebook, which details the scientific concepts involved in each activity; presenting these activities with peers acting as the elementary students; refining the presentation of each scientific concept so it is age appropriate in method of presentation as well as materials being used during the presentation; organizing the materials into an activity kit, and finally sharing the activities with classes of children. An outreach project involving college chemistry students can help make chemistry approachable for elementary students, combat scientific illiteracy and increase the chemical confidence for college students and elementary students alike (Altman, 2007).

There are benefits for the children who are recipients of outreach by college students. The children, by having direct contact with students, have the opportunity to question the students about the scientific concepts as well as college experiences. Children who participate in outreach events have an increase in college awareness, an increase in their own scientific curiosity, a new perception of what science is and how science can be fun (LaRivier, et al., 2007). Early exposure to outreach experiences in K-12 education is important in order to develop proper curriculum building to ensure preparedness for college success (Fusch, 2010).

Elementary school children exposed to college student outreach are inspired to learn how to overcome the barriers of going to college. These barriers might include how to apply for admissions, financial aid, or facing the uncertainties of dorm life (Fusch, 2010). Smith's (1995) description of college students going into a local hospital to do outreach activities with the children represents another type of barrier elementary school children may run into. In this instance, college students work with museum staff to promote a more positive healing environment, teach the children a bit about form and content, and give them a creative outlet. Broton (2009) reports that

> …pre-college outreach programs improve college access for underrepresented groups, including low-income, first-generation, and minority students… by

> promoting college awareness and attendance, improving academic skills, building student self-esteem, and providing role models. One study has shown that successful outreach programs can nearly double the odds of enrollment for moderate- to high-risk students (p. 2).

Broton (2009) suggests key features of achieving successful outreach programs which include, in part, early intervention, preferably prior to high school. The most successful outreach programs/experiences are long-term experiences which link the levels of education by aligning curricular requirements of secondary and post-secondary educational systems. This guides those children in the low-income and minority categories to a more successful educational experience. Altman (1996) proclaims the need for new/renewed relationships including those between institutions and their communities which would link curriculum to community needs.

During one service learning course focusing on chemical outreach, college students worked with small groups of elementary children to refine the chemistry presentations they had been working on (LaRiviere, 2007). This small group opportunity provided a personalized experience for the college students as well as the elementary students in which guided inquiry took place between all individuals involved.

The above findings were used to develop the methodology for this project. LaRiviere (2007) was a main source for the design of the questionnaires used in the data collection as well as the organization of the science outreach visits. Other sources provided supplementary information and guidance to incorporate this science service learning project.

METHODOLOGY

My capstone project spanned from late November, 2010 through May, 2011. During the planning stages of the project, a service learning course was set up and details of the course arranged. During the implementation of the capstone project, I worked with a group of five college students on a scientific outreach service learning project with elementary students in the kindergarten (*N*=21) and fifth grade (*N*=18) of Jeannette Myhre Elementary School. Four of the five students volunteered to work with the project after announcements in class offering experience and one free service learning credit. One student was advised to participate in the project when he needed one more enrichment credit to graduate. I initially had three more interested students but they were unable to complete the project with us due to scheduling difficulties.

The service learning college students met once a week for one to two hours to discuss and practice activities as well as summarize completed activities. These students were assigned tasks to complete as their part of the upcoming outreach activities. The outreach portion of the project consisted of four visits to the kindergarten class and five visits to the fifth grade class which included presentations and performance of hands-on science experiments by college students adapted from various sources to fit with the college students' level of comfort about the chosen scientific concepts as well as the appropriate grade level presentation for the elementary classroom. These visits lasted just under one hour each including set-up, presentation, and clean-up.

Activities presented (Table 1) were adapted from various sources including the Exploratorium Museum of Science, Art, and Human Perception out of San Francisco, CA. This museum provides many "Science Snacks" activities on their website as well as in many publications. The American Chemical Society's Community Outreach has online guidelines for a successful outreach program as well as many activities that are "developmentally appropriate and support the required curriculum" (ACS, 2010). We also referred to the Chemistry in Art course co-taught at BSC by Barb Jirges, art instructor, and me. The activities described in Table 1 are summarized in Appendix K.

Table 1
Activities Presented at Jeannette Myhre Elementary School.

Activity Description	K	5th	Concept	Date
Polage Permanent Rainbows	X	X	Color of Light Interference Patterns Polarization	4/8
Ziploc Chemistry Heat in a Click Packs	X	X	Chemical & Physical Changes and Reactions and Saturated solutions	5th- 4/1 K- 4/29
Magnet Play and Observation	X	X	Magnetism	4/15
Anodizing Niobium	-	X	Reactions with oxygen Forms of "rust"	5th- 5/6
SunPrints	X	X	Photochemical Reactions	5/10

I acquired the elementary school's survey documentation about college awareness from *The Gallup Student Poll* 2009 which provided background information of the Myhre Elementary students' levels of hope being less than 50%. Specifically I noted their responses to the "I will graduate from high school" and "I know I will find a good job after I graduate" prompts (p. 9). These responses provided the background data for college awareness of the elementary students at Myhre Elementary.

The College Student Pre-Outreach Questionnaire was, like all the questionnaires used in this study were adapted from LaRiviere and focused around the college students' outreach expectations and outlooks (Appendix A). It also asked about their own college readiness and needs, how they expected to use their outreach opportunity to empower the students they work with and scientific interests beyond the classroom. The College Student Post-Outreach Questionnaire focused around the college students' outreach experience and how it affected them as students, citizens, and mentors to the elementary students (Appendix B). Many of the questions were posed in a Likert-like manner in order to make the data analysis more manageable. Other questions were open-ended to ensure richer data for further research opportunities. The open-ended questions were analyzed for the presence of themes and outliers that reinforced or disproved the value of outreach-service learning experiences. The results of each of these questionnaires were reported via graphs pertaining to a Likert-like scale.

The data provided about elementary students was collected via the Fifth Grade Student Pre-Outreach Questionnaire and the Kindergarten Student Pre-Outreach Questionnaires (Appendix C & D). These two questionnaires solicited what the students' thoughts were of science in general prior to their outreach experience. Questions also referred to stereotypes of scientists in the manner of drawing a scientist. After the outreach experience, both classes of students were given questionnaires nearly identical except for the last inquiry which asks about their personal outreach experiences (Appendices E & F). Like the College Student Pre-/Post-Outreach Questionnaires, many of the questions were posed in a Likert-like manner in order to make the data analysis more manageable. Other questions were open-ended to ensure richer data for further research opportunities. The open-ended questions were analyzed for the presence of themes and outliers that reinforced or disproved the value of outreach-service learning experiences. The results of each of these questionnaires were reported via graphs pertaining to a Likert-like scale.

The teachers involved in the outreach experience were asked to participate by completing an Elementary Teacher and Administrator Pre-/Post-Outreach Questionnaire (Appendix G). This questionnaire was identical for both the pre- and post-outreach experience. The information gathered from this instrument showed the teacher's attitude and awareness both of his/her class and his/her own self toward science and college. Like the College Student Pre-/Post-Outreach Questionnaires, many of the questions were posed in a Likert-like manner in order to make the data analysis more manageable. Other questions were open-ended to ensure richer data for further research opportunities. The open-ended questions were analyzed for the presence of themes and outliers that reinforced or disproved the value of outreach-service learning experiences. The results of each of these questionnaires were reported via graphs pertaining to a Likert-like scale.

Personal journal entries were used to record observations of college students as they prepared to do their outreach project, observations of the elementary students as they worked with the college students and notes taken from meetings and interviews with the teachers, administrators, college and elementary students. After each outreach visit, the college students and I gathered for a wrap-up session in which we discussed the events of the day, how the elementary students reacted to the hands-on activities as well as their interest to the career/college connections.

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained. An Informed Consent Form was provided to each elementary student's parent/guardian (Appendix H).

The uses for the previously mentioned questionnaires and journals are summarized in the following triangulation matrix:

Table 2
Triangulation Matrix

Focus Question:	Data Source 1	Data Source 2	Data Source 3
Primary Question: 1. What are the effects of science outreach by college students with elementary school students?	College Student Pre and Post-Outreach Questionnaires	Fifth Grade and Kindergarten Student Pre and Post-Outreach Questionnaires	Instructor observations
Secondary Questions: 2. How does service learning outreach experience affect the science content knowledge of college students?	College Student Post-Outreach Questionnaires	Instructor Observations	College Student Journaling
3. How does service learning outreach experience empower the college student?	College student journaling	College Student Pre and Post-Outreach Questionnaires	Instructor observations and journaling
4. How does service learning outreach experience affect the science content knowledge of an elementary student?	Elementary Teacher/Administrator Pre and Post-Outreach Questionnaire	Elementary Teacher comments and observations	Instructor observations
5. How does service learning outreach experience empower the elementary student to have a hopeful future which includes college aspirations?	Pre and Post-Outreach Fifth Grade Students Questionnaires	Pre and Post-Outreach Kindergarten Students Questionnaire	Elementary Teacher/Administrator Pre and Post-Outreach Questionnaire

DATA AND ANALYSIS

The results of the College Student Pre-Outreach Questionnaire indicated that most students were interested in science, most were first generation college students (80%) (*N*=5). In addition, 80% of college students felt self-motivated, 20% of college students had good study habits, 20% of college students knew how to manage time, and even though 80% of the college students felt prepared for college, 0% of college students felt prepared for college science courses (Figure 1).

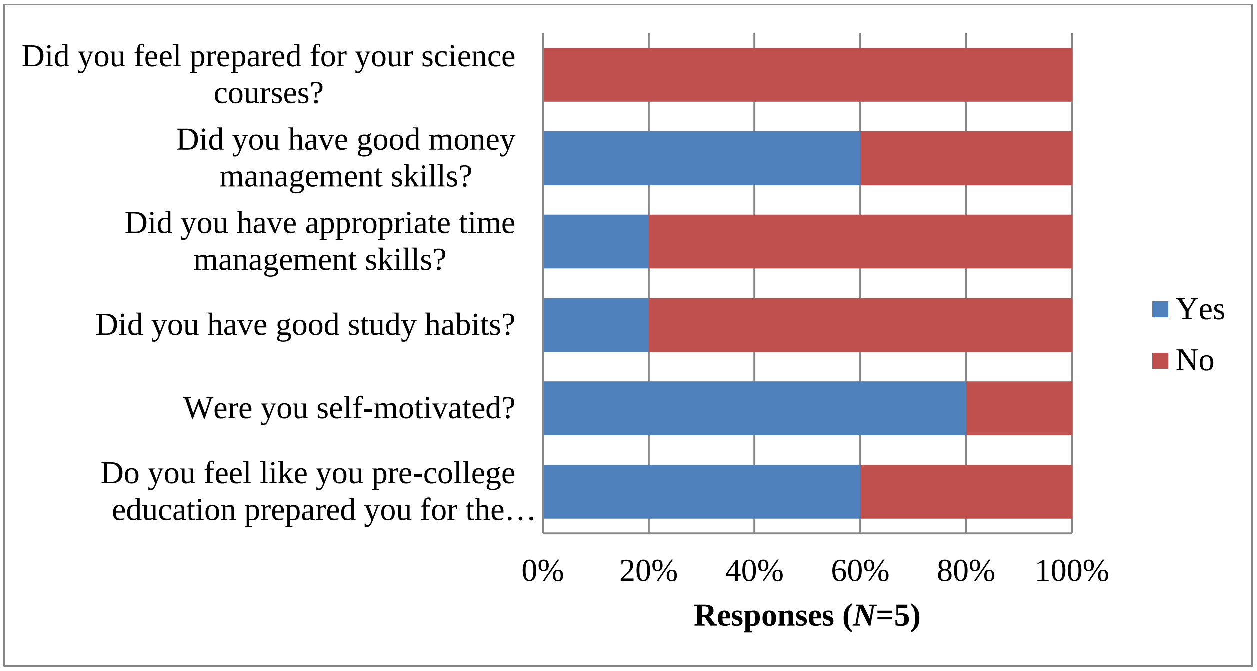

Figure 1. College Preparedness, (*N*=5).

The next series of questions referred to a college student's interest in science by asking about one's activities that included science or scientific topics. When asked about their television viewing habits, 100% of college students included scientific shows as part of their viewing practices. Eighty percent of students liked to read about science and 100% of them liked doing experiments (Figure 2).

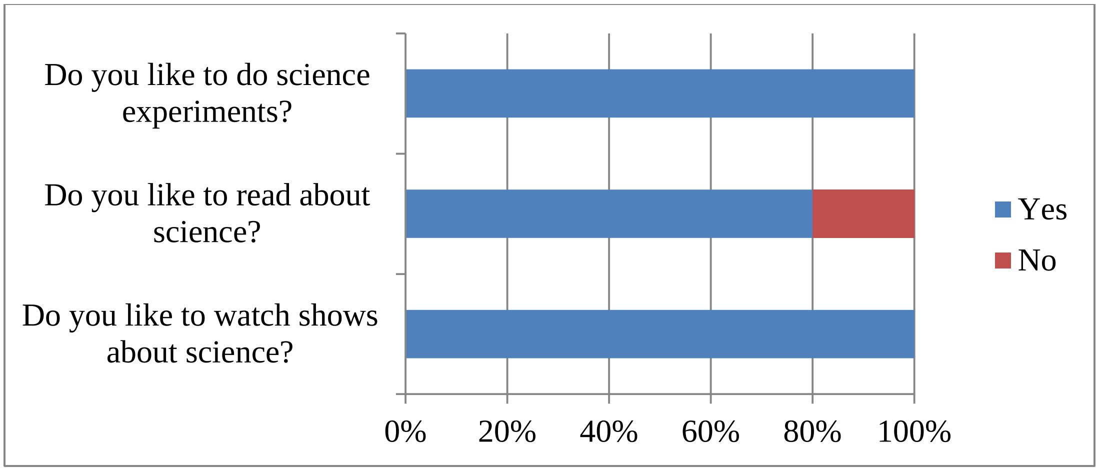

Figure 2. College Students' Science Interest Level, (*N*=5).

The results of the College Student Post-Outreach Questionnaire indicated that most students thought the outreach experience increased their ability to apply course concepts to new real-world situations (60%) and increased their community engagement (100%).

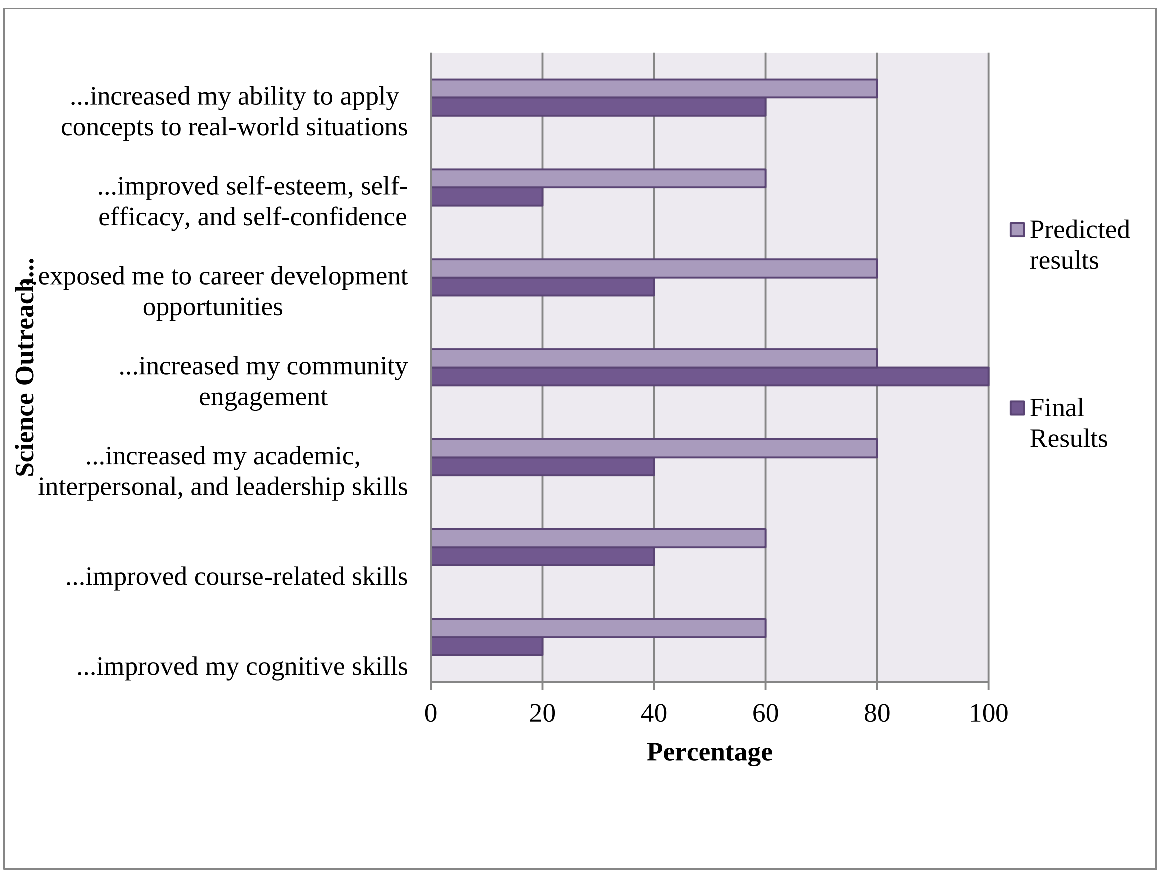

Figure 3. Outreach Did…, (*N*=4).

Results of the Kindergarten Pre and Post-Outreach Questionnaires (Figure 4 and Figure 5) both indicated that most kindergarten students think science is pretty fun (Pre- 14%; Post-17%) or very fun (Pre- 76%; Post- 67%) and would like to learn more about science (Pre- 67%; Post 67%).

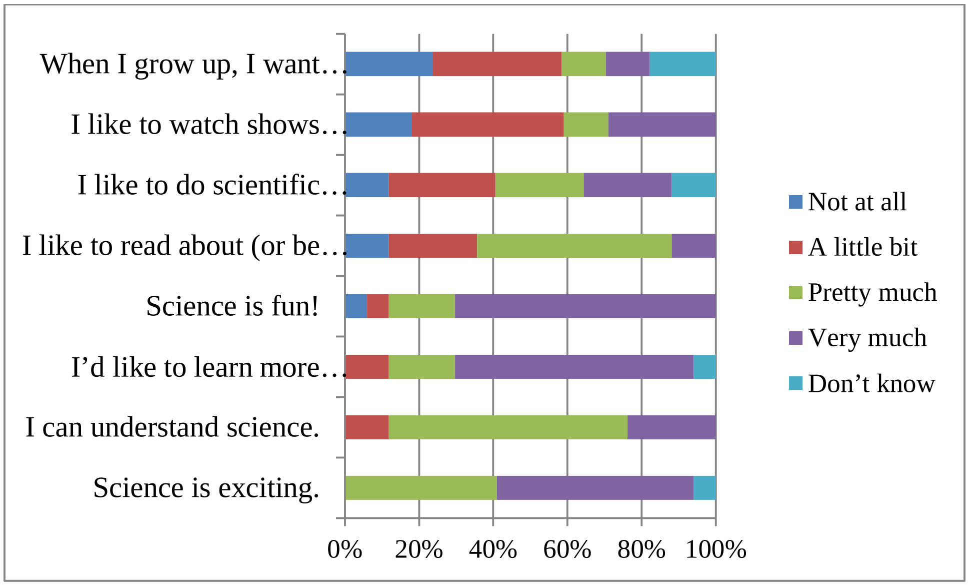

Figure 4. Science Attitudes Pre-Outreach- Kindergarten, (*N*=17).

Prompts:

- When I grow up, I want to be a scientist.
- I like to watch shows about science.
- I like to do scientific experiments at home?
- I like to read about (or be read to about) science.
- Science is fun!
- I'd like to learn more science.
- I can understand science.
- Science is exciting.

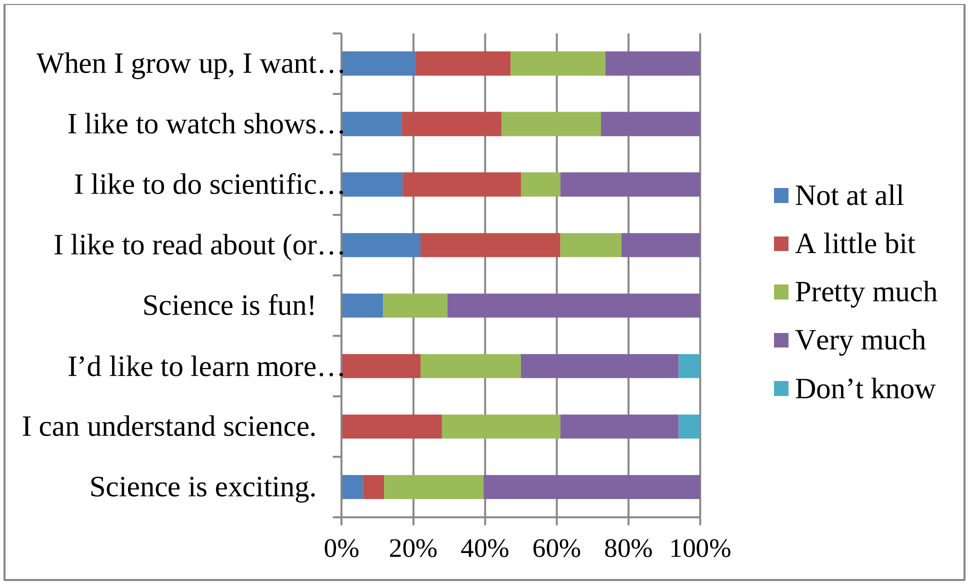

Figure 5. Science Attitudes Post-Outreach- Kindergarten, (*N*=18).

Prompts:

- When I grow up, I want to be a scientist.
- I like to watch shows about science.
- I like to do scientific experiments at home?
- I like to read about (or be read to about) science.
- Science is fun!
- I’d like to learn more science.
- I can understand science.
- Science is exciting.

The Fifth Grade Students Post-Outreach Questionnaire (Figure 6) also looked at college awareness. Responses by the fifth grade students to the question “Who do you know, other than a teacher, who has gone to college?” include 22% have had both parents attend college, 28% have had one parent attend college, 17% have had a sibling attend college, 11% another relative, 17% some other acquaintance, and 22% of the elementary students knew no one who had attended college.

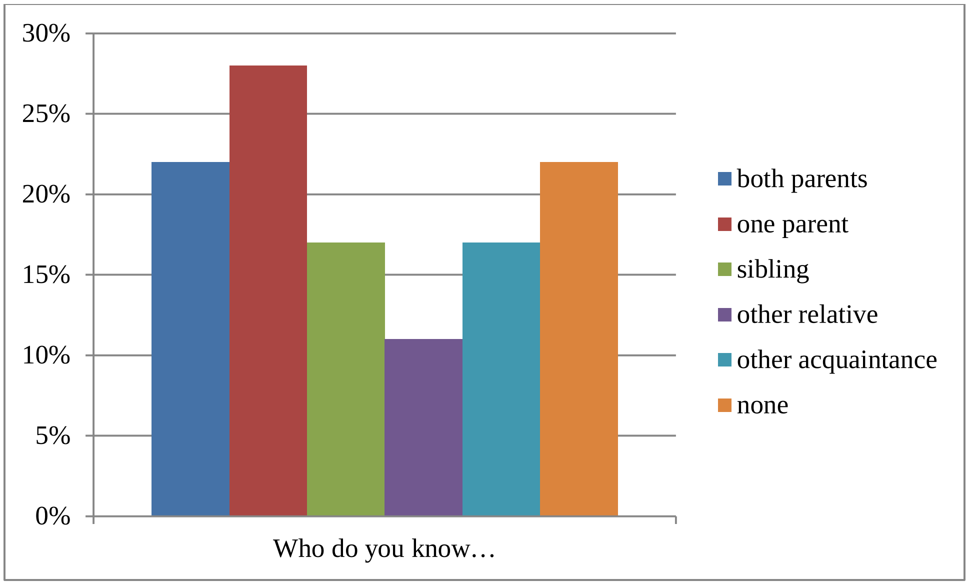

Figure 6. Who Do You Know Who has Gone to College? (*N*=18).

The Elementary Teacher Pre- & Post-Outreach Questionnaire was completed by the classroom teachers from the kindergarten and the fifth grade classes which participated in the project. The teachers agreed 100% that the outreach project was *very positive* experience for the elementary students. This idea is supported by college student journal entries saying "the teachers of the classrooms were also very excited for their students to have the opportunity to participate in the individual experiments." The fifth grade teacher told me "the other classes were jealous of his class getting to do these additional science activities." The elementary teachers also agreed 100% that their elementary students thought a college experience is a positive experience. Fifty percent of the teachers thought their students' attitudes about science were *very positive* while the other fifty percent of the teachers thought their students' attitudes were *neutral*.

INTERPRETATION AND CONCULSION

This capstone project set out to answer questions about the effects of a service learning science outreach project where college students went into elementary classrooms to share science experiments. The first focus question, “Does a service learning outreach experience empower the college student,” wasn’t really foreclosed in the questionnaires but, I observed the college students took hold of this project and made it their own. Even though I was in charge of materials, they presented the major portions of the activities and guided the students toward the intended goals of each experiment to the best of their abilities within the given time available. The elementary students seemed to cling onto the college student’s every word. As the classroom visits progressed, the college students would bring more ideas and extensions of activities as well as offer suggestions for improvement. I believe that acknowledging empowerment is not a very easy thing to recognize and the college students may have passed it over.

The other focus question about empowering an elementary student to have a hopeful future was accomplished rather behind the scenes. Many college students would wear their Bismarck State College t-shirts or sweatshirts to the outreach visits. We also made sunprints which had their school logo along with one of their school phrases “No Excuses!” on one side and their high school graduation date on the other.

Figure 7. Cyanotypes from the Kindergarten Class

We worked very hard to establish school pride as well. For our anodizing niobium project, I had an artist friend bend wires to represent Myhre Mustangs and their school color. These niobium wires were scripted letter M's with a red bead in the middle- Myhre Elementary school colors. These wires also read "MoM" for those who incorporated the bead as an "o"… perfect considering that Sunday was Mother's Day! Many of the fifth grade students were thrilled to be able to present something they had made to their moms.

Another valuable aspect of the project was sheer exposure to college students. The elementary school student questionnaire responses showed that a lot of students had very little exposure to anyone who had attended college. Therefore, the majority of the elementary students were most likely unaware of what college may entail and how a college student is just a normal person working toward a career goal through education. The college students coming into their classrooms and working with the elementary school students allowed an open question time for those elementary students to ask questions about college and a college experience.

Overall, I believe this project met its intended goals of building a science mentoring relationship between college students and elementary students. It also set up a fairly good template of what works (and what needs to be improved upon) for future service learning projects. The goals of affecting science content knowledge were not measured against elementary science curriculum due to lack of science curriculum and time in the elementary classroom. I knew we were doing a good thing when we walked into the school after just one visit and one fifth grader shouted "the scientists are here!" as she skipped back to class—excited for the activities we were bringing in. One of the college students wrote in her journal entry:

> "One of the kids …took a liking to me the first time we came to the school. She has some scars on her face and I imagine school can be tough sometimes… when she saw me she came over and told me about the magnetic car and asked if I could help her untie her apron. I did and she gave me a big hug. My heart melted and I was so pleased that she made a personal connection. This will help her remember us and the experiments in a positive way…"

Another student wrote about the fact that elementary teachers are forced to focus on reading and math and science doesn't get much attention at all. She commented "After this experience, I look at science in a whole new way. It was fun." She also mentioned expanding an outreach program to other elementary schools in order to benefit both elementary and college students alike and ended her journal entry with this: "Just think of all the great things and ideas students could learn with a major science program incorporated into their schools. I think our kids are worth the try!"

VALUE

The most valuable takeaway I have from this project is that my pipedream of an outreach project having college students helping elementary students could and does really work! This project is something I have talked about for a few years but didn't think was feasible to pursue until I had finished my master's degree and settled into my teaching position until a phone call to a friend this past fall. This is where my dreams and capstone project collided. The support of my idea has been amazing! I have been asked to help create a template for service learning projects at Bismarck State College, the college is even considering at least a part-time position to manage service learning projects—quite possibly me. I have also had other people offer services I didn't even know existed such as career counseling (which I wanted to incorporate a bit of that into my classroom visits but time did not allow). I have made connections that would not have been possible had I not taken on this challenge.

Although I wasn't able to focus on measuring the increase of science content knowledge of the college and elementary students, I have many observations that should allow for further research to develop answers to how science outreach with college students would affect the content knowledge of both the college students and elementary students. There was information within the student journals that actually supported the idea that science outreach improved course-related skills and cognitive skills. One college student commented that the science outreach project allowed him "to try fun and new activities and [gave him] the chance to teach the children what [he] learned." If we lean more on the journal results than the actual questionnaire results, this cognitive and conceptual knowledge increase could be attributed to the fact that the college student is repeating what he or she has already learned thus reinforcing knowledge. It is also likely due to the fact that knowing a concept or property enough to teach someone else that same concept or property takes additional studying to learn the material thoroughly.

As for the elementary students, the activities we did didn't really correlate as much as I had wished they would with the standard curriculum mainly because the standards especially for the kindergarteners were so broad that it was difficult to try to focus in on any specific content area so, most of the content was rather new. When I discussed activities with the elementary teachers, they just said "anything you do will be great." There had been little focus on science education during the school normal day due to the vast amount of time spent with reading and math education so; anything we brought in was received enthusiastically by all.

We did strive to correlate things to the elementary students' own experiences such as when we anodized niobium with the fifth graders, we were reacting oxygen with niobium metal which we could roughly correlate to a type of rust—everyone knew what rust was. This, therefore, gave them a greater awareness of how metals can react. We also looked at experiments to note physical and chemical changes. These experiments were enjoyed especially by the kindergarteners! They loved the Ziploc chemistry experiment in which there were color changes, temperature changes, gas formation… and possibly a blown up baggie if too much carbon dioxide was produced. The intent of increasing content knowledge by showing students was put slightly on the back burner in order to allow curiosity to build a bit more which then allowed the students to develop their own knowledge through hands-on activities. One of my standout moments was when the kindergarten teacher came up to me the week after we brought in magnets for exploration and told me about a very quiet student who rarely participated in class who pulled the teacher aside and told her “I figured that out on my own!” when I had mentioned some property of the magnets. In my mind, that was success!

Things that could have been improved would be having more planning time to get set up to do such a project. Not only did I have to get together students and assist with materials for the activities but I had to clear a pathway to allow our students to come into the elementary school and earn a service learning credit for their time and efforts. None of this was extremely difficult; it all just took way more time than I could anticipate. In the future, I would like to have time set aside to be able to plan more effectively and communicate more efficiently with all parties involved in order to have a program that is something that people will take notice and brag about.

As a teacher, I have learned that the hands-on activities shared with elementary students by college students encourage interest and enthusiasm about chemistry—that seems to be one of the hardest parts about getting students going. Students often don’t get to see and participate in the fun part of science which would show them that it can be interesting. These activities sparked an interest in chemistry that goes far beyond the “jumping through the hoops” attitude many have about chemistry. Long-term goals include aligning some of the activities to enhance the existing science curriculum for the elementary students.

Of the open response questions, one teacher commented that an inspirational scientist in his/her life was” a high school science teacher”, the other commented that “Ben Franklin [was because he] covered a wide area and was integrated.” I found this comment to be very valuable because “integration” is a very hot topic included with other catch words like “collaboration” and “innovation.” Therefore, when running into this journal entry from the college student, I took notice of it for future use that more collaboration between the levels of education as well as integration among concepts and core subjects needs to be done. This is a need that extends beyond basic desire… it is something that should be incorporated into each level of education and college students.

Another way this project changed me is in the group of college students I worked with. Of this group of five wonderful people, four of them were parents. These people saw the value in this idea and supported it wholeheartedly… we tossed ideas around about how they encouraged the elementary students to go home and talk about college to their parents. As an extension, we even started exploring alternate pathways toward higher education for the parents of the elementary students on site at the elementary school where college students would do outreach with the elementary students while the parents participated in some sort of educational course or workshop. One of the barriers that quickly came up was funding—we’re exploring options of an “earn to learn” type option where parents would be able to earn their way to a higher education, kind of like a barter system. This would also empower the parents to share the skills they did have to earn skills they need.

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APPENDICES

APPENDIX A

COLLEGE STUDENT PRE-OUTREACH QUESTIONNAIRE

Appendix A
College Student Pre-Outreach Questionnaire

College Student Pre-Outreach Questionnaire

Participation in this questionnaire is voluntary. You can stop at any time. You can choose not to answer any questions you don't want to answer and your grade or class standing will not be affected.

Directions: Circle the corresponding scaled answer for each question. For those questions with no rankings, provide written answers.

1. My career goals are _________.

2. Are you a first generation college student?___

3. What was the most influential experience/opportunity/event that has happened to you that made you attend college? Would you be willing to share this story?

4. Do you feel like your pre-college education prepared you for the expectations of college? *yes / no*
   a. Were you self-motivated? *yes / no*
   b. Did you have good study habits? *yes / no*
   c. Did you have appropriate time management skills? *yes / no*
   d. Did you have good money management skills? *yes / no*
   e. Did you feel prepared for your science courses? *yes / no*

5. If you could go back to your pre-college educational experiences, how do you think opportunities to interact with college students through an outreach program could have helped you be more prepared for and aware of the opportunities college has to offer?

6. Do you like to watch shows about science? *yes / no*
   Which ones? (Please list in the space below.)

7. Do you like to read about science? *yes / no*
   What is one of your favorite books about science? (Please list in the space below.)

8. Do you like to do science experiments? *yes / no*

If yes, give an example of one of your favorites and the reasoning why. (Please list in the space below.)

Complete the following statements.

9. I want to take part in an outreach experience with elementary students because I think it will benefit me in the following ways. (select all that apply)

   Outreach will…

   a. improve my cognitive (thinking, reasoning, remembering) skills
   b. improve my course-related skills and self-reported learning outcomes.
   c. increase my academic, interpersonal, and leadership skills.
   d. increase my community engagement.
   e. expose me to career development opportunities.
   f. improve my self-esteem, self-efficacy (effectiveness, self-worth), and self-confidence.
   g. increase my ability to apply course concepts to new real-world situations.
   h. Other: ____ ____________________________________

10. I want to take part in an outreach experience with elementary students because I think I can make a difference in an elementary student's life by:

   - ☐ being a mentor to a child
   - ☐ empowering a child to improve his/her self-worth
   - ☐ empowering a child to learn science
   - ☐ empowering a child to think science is fun
   - ☐ empowering a child to be curious about science
   - ☐ other: ____ ________

11. I think an outreach experience will enhance my scientific knowledge by…

12. I think an outreach experience will enhance my own ability to be an educated citizen in the following ways…

13. My most favorite scientific experience has been… (Be specific. Things might include: experiments, books, TV shows, science museum…)

14. An inspirational scientist in my life has been…

APPENDIX B

COLLEGE STUDENT POST-OUTREACH QUESTIONNAIRE

Appendix B
College Student Post-Outreach Questionnaire

College Student Post-Outreach Questionnaire

Participation in this questionnaire is voluntary. You can stop at any time. You can choose not to answer any questions you don't want to answer and your grade or class standing will not be affected.

Directions: Circle the corresponding scaled answer for each question. For those questions with no rankings, provide written answers.

Complete the following statements.

1. My outreach experience
    a. improved my cognitive (thinking, reasoning, remembering) skills
    b. improved my course-related skills and self-reported learning outcomes.
    c. increased my academic, interpersonal, and leadership skills.
    d. increased my community engagement.
    e. exposed me to career development opportunities.
    f. improved my self-esteem, self-efficacy (effectiveness, self-worth), and self-confidence.
    g. increased my ability to apply course concepts to new real-world situations.
    h. Other: ____ ____________________________________

2. By taking part in the outreach experience, I feel I made a difference in an elementary student's life by:
    - ☐ being a mentor to a child
    - ☐ empowering a child to improve his/her self-worth
    - ☐ empowering a child to learn science
    - ☐ empowering a child to think science is fun
    - ☐ empowering a child to be curious about science
    - ☐ other: ____ ________

3. The outreach experience enhanced my scientific knowledge by…

4. The outreach experience enhanced my own ability to be an educated citizen in the following ways…

5. The most memorable moment of my outreach experience was…

APPENDIX C

FIFTH GRADE STUDENTS PRE-OUTREACH QUESTIONNAIRE

Appendix C
Fifth Grade Students Pre-Outreach Questionnaire

Fifth Grade Student Pre-Outreach Questionnaire-
Science & College- Attitude & Awareness

Participation in this questionnaire is voluntary. You can stop at any time. You can choose not to answer any questions you don't want to answer and your grade or class standing will not be affected.

Directions: Circle the corresponding scaled answer for each question. For those questions with no rankings, provide written answers. (Note: Children who are not proficient in reading & writing are to be assisted by an adult who will read the questions and record the child's responses without trying to influence those responses.)

1. **Science is exciting.**

   not at all   a little bit   pretty much   very much!   Don't know

2. **I can understand science.**

   not at all   a little bit   pretty much   very much!   Don't know

3. **I'd like to learn more science.**

   not at all   a little bit   pretty much   very much!   Don't know

4. **Science is fun!**

   not at all   a little bit   pretty much   very much!   Don't know

5. **I like to read about (or be read to about) science.**

   not at all   a little bit   pretty much   very much!   Don't know

   My favorite scientific book is (Please answer below.)

6. **I like to do scientific experiments at home?**

   not at all   a little bit   pretty much   very much!   Don't know

   My favorite experiment (Please answer below.)

7. I like to watch shows about science.

not at all a little bit pretty much very much! Don't know

Some of my favorite shows about science are: (Please answer below.)

8. When I grow up, I want to be a scientist

not at all a little bit pretty much very much! Don't know

Directions: Answer each question in the spaces provided.

9. What is science?

10. What has been your most favorite thing about science? (experiments, books, TV shows, science museum, other)

11. Who do you know, other than a teacher, who has gone to college?

12. What do you think college is like?

13. Your gender: (Circle one.)

Boy Girl

14. Draw a picture of a scientist.

APPENDIX D

KINDERGARTEN STUDENTS PRE-OUTREACH QUESTIONNAIRE

Appendix D
Kindergarten Student Pre-Outreach Questionnaire

Kindergarten Student Pre-Outreach Questionnaire-
Science- Attitude & Awareness

Participation in this questionnaire is voluntary. You can stop at any time. You can choose not to answer any questions you don't want to answer and your grade or class standing will not be affected.

Directions: Circle the corresponding scaled answer for each question. For those questions with no rankings, provide written answers. (Note: Children who are not proficient in reading & writing are to be assisted by an adult who will read the questions and record the child's responses without trying to influence those responses.)

1. Science is exciting.

not at all a little bit pretty much very much! Don't know

2. I can understand science.

not at all a little bit pretty much very much! Don't know

3. I'd like to learn more science.

not at all a little bit pretty much very much! Don't know

4. Science is fun!

not at all a little bit pretty much very much! Don't know

5. I like to read about (or be read to about) science.

not at all a little bit pretty much very much! Don't know

6. I like to do scientific experiments at home?

not at all a little bit pretty much very much! Don't know

7. I like to watch shows about science.

not at all a little bit pretty much very much! Don't know

8. Some of my favorite shows about science are: (Circle all that you like)

- Sid the Science Kid
- Phineus & Ferb
- Webster
- MythBusters
- Anything on Discovery, Science, Animal planet, or TLC Channels
- Big Bang Theory
- Zoboomafoo

- Jimmy Neutron
- Brain Surge
- Other: ______________________
____

9. When I grow up, I want to be a scientist.

not at all | a little bit | pretty much | very much! | Don't know

10. What is science?
11. What has been your most favorite thing about science so far? (experiments, books, TV shows, science museum, other)
12. Gender: (Circle one.)

Boy | Girl

13. Draw a picture of a scientist.

APPENDIX E

FIFTH GRADE STUDENTS POST-OUTREACH QUESTIONNAIRE

Appendix E
Fifth Grade Student Post-Outreach Questionnaire

Fifth Grade Student Post-Outreach Questionnaire-
Science & College- Attitude & Awareness

Participation in this questionnaire is voluntary. You can stop at any time. You can choose not to answer any questions you don't want to answer and your grade or class standing will not be affected.

Directions: Circle the corresponding scaled answer for each question. For those questions with no rankings, provide written answers. (Note: Children who are not proficient in reading & writing are to be assisted by an adult who will read the questions and record the child's responses without trying to influence those responses.)

1. **Science is exciting.**

   not at all   a little bit   pretty much   very much!   Don't know

2. **I can understand science.**

   not at all   a little bit   pretty much   very much!   Don't know

3. **I'd like to learn more science.**

   not at all   a little bit   pretty much   very much!   Don't know

4. **Science is fun!**

   not at all   a little bit   pretty much   very much!   Don't know

5. **I like to read about (or be read to about) science.**

   not at all   a little bit   pretty much   very much!   Don't know

   My favorite scientific book is(Please answer below.)

6. **I like to do scientific experiments at home?**

   not at all   a little bit   pretty much   very much!   Don't know

   My favorite experiment (Please answer below.)

7. **I like to watch shows about science.**

not at all a little bit pretty much very much! Don’t know

Some of my favorite shows about science are: (Please answer below.)

8. When I grow up, I want to be a scientist

not at all a little bit pretty much very much! Don’t know

Directions: Answer each question in the spaces provided.

9. What is science?

10. What has been your most favorite thing about science? (experiments, books, TV shows, science museum, other)

11. Who do you know, other than a teacher, who has gone to college?

12. What do you think college is like?

13. Your gender: (Circle one.)

Boy Girl

14. The most memorable moment of my outreach experience was...

APPENDIX F

KINDERGARTEN STUDENTS POST-OUTREACH QUESTIONNAIRE

Appendix F
Kindergarten Student Post-Outreach Questionnaire

Elementary Kindergarten Student Post-Outreach Questionnaire-
Science- Attitude & Awareness

Participation in this questionnaire is voluntary. You can stop at any time. You can choose not to answer any questions you don't want to answer and your grade or class standing will not be affected.

Directions: Circle the corresponding scaled answer for each question. For those questions with no rankings, provide written answers. (Note: Children who are not proficient in reading & writing are to be assisted by an adult who will read the questions and record the child's responses without trying to influence those responses.)

1. **Science is exciting.**

   not at all a little bit pretty much very much! Don't know

2. **I can understand science.**

   not at all a little bit pretty much very much! Don't know

3. **I'd like to learn more science.**

   not at all a little bit pretty much very much! Don't know

4. **Science is fun!**

   not at all a little bit pretty much very much! Don't know

5. **I like to read about (or be read to about) science.**

   not at all a little bit pretty much very much! Don't know

6. **I like to do scientific experiments at home?**

   not at all a little bit pretty much very much! Don't know

7. **I like to watch shows about science.**

   not at all a little bit pretty much very much! Don't know

8. **Some of my favorite shows about science are: (Circle all that you like)**

Sid the Science Kid
Phineus & Ferb
Webster
MythBusters
Big Bang Theory
Zoboomafoo
Brain Surge
Jimmy Neutron
Anything on Discovery, Science, Animal planet, or TLC Channels
Other: ________________________
____

9. **When I grow up, I want to be a scientist**

not at all   a little bit   pretty much   very much!   Don't know

10. **What is science?**

11. **What has been your most favorite thing about science so far? (experiments, books, TV shows, science museum, other)**

12. **Gender: (Circle one.)**

Boy   Girl

13. **What has been your favorite part of the outreach experience?**

14. **Draw a picture of a scientist.**

APPENDIX G

ELEMENTARY TEACHER/ADMINISTRATOR PRE-& POST-OUTREACH QUESTIONNAIRE

Appendix G
Elementary Teacher/Administrator Pre- & Post-Outreach Questionnaire

Elementary Teacher/Administrator
Pre- & Post-Outreach Questionnaire
Science & College Awareness

Participation in this questionnaire is voluntary. You can stop at any time. You can choose not to answer any questions you don't want to answer without penalty.

Directions: Circle the corresponding scaled answer for each question. For those questions with no rankings, provide written answers.

1. How do you think college science students coming in to do outreach in your classroom might benefit or has benefitted your students' science experience and college awareness?

Very positively	Positively	Neutral	Negatively	Very negatively

2. What do you think your students' idea of a college experience is?

Very positive	Positive	Neutral	Negative	Very negative

3. What are the attitudes of your students about science?

Very positive	Positive	Neutral	Negative	Very negative

4. What science activities make your students most excited?

5. Do you like to watch shows about science? Which ones?

6. Do you like to read about science? What is one of your favorite books about science?

7. Do you like to do science experiments? If yes, give an example of one of your favorites and the reasoning why.

8. What has been your most favorite scientific experience so far? (Be specific. Things might include: experiments, books, TV shows, science museum…)

9. Who has been an inspirational scientist in your life?

10. If you had a guest scientist come to your classroom or come again, what would you like to ask them? Or, what kind of activities would you like to see them do with your students?

11. Your Gender: Male Female

12. Your Role: Teacher Administrator Teacher's Aide Parent

13. Please add any additional comments below.

APPENDIX H

CONSENT FORM FROM JEANNETTE MYHRE ELEMENTARY SCHOOL PRINCIPAL

Appendix H
Consent Form From Jeannette Myhre Elementary School Principal

BISMARCK PUBLIC SCHOOLS

DR. JEAN HALL
PRINCIPAL

LINDA ANDERSON
[illegible]

Exemption Regarding Individually Signed Informed Consent Slips

I, Dr. Jean Hall, Principal of Jeannette Myhre Elementary School, verify that the classroom research conducted by JoDean "JoDe" Knutson-Person is in accordance with established educational practices that are commonly accepted within normal educational settings. According to school policy, parents have been informed about this project and have been given permission to deny their child's participation in the project. For this reason, I have granted JoDean "JoDe" Knutson-Person exemption from individually signed parent consent slips.

Jean Hall
(Signed Name)

Jean Hall
(Printed Name)

12-01-2010
(Date)

APPENDIX I

INFORMATION LETTER FOR PARENTS/GUARDIANS OF JEANNETTE MYHRE ELEMENTARY SCHOOL

Appendix I
Information Letter for Parents/Guardians of Jeannette Myhre Elementary School

December 14, 2010

SUBJECT CONSENT FORM FOR PARTICIPATION IN HUMAN RESEARCH AT MONTANA STATE UNIVERSITY

Dear Parent or Guardian,

You are being asked to allow your child to participate in a research study of *The Effects of Science Outreach by College Students with Elementary School Children.* This study will bring college students into your child's classroom to increase awareness of science as well as empower them to look toward college being part of their future goals.

This project will take place from January through May of 2011. A group of college students, monitored by me and the classroom teacher, will come into your child's classroom about once a month to do a hands-on science activity which coordinates with their science curriculum. During that time, your student will be working in a small group setting with college students in order to discuss the scientific concepts involved and how interest in these topics can lead to very fulfilling career goals. Toward the end of the school year, we plan on providing either a school assembly or science fun day to celebrate our time together.

Participation is voluntary and your child can choose to not answer any questions he/she does not want to answer. He/she can also stop at anytime. Participation or non-participation in this project will not affect his/her grade or class standing. Participation will involve your child to fill out (or respond to) a questionnaire prior to the college outreach students coming in and again after the series of visits is complete. Only group analysis will be involved in the final documentation. There will be photos/videos taken of these group activities and random brief interviews of students that may become part of my final presentation of which, any identifying information will be edited out.

There are no foreseen risks involved with this project. If completing any of the questionnaires makes your student uncomfortable at any time, he/she can stop. Any information collected from this study will be kept confidential and your child's identity will be protected at all times unless you personally request otherwise.

SUBJECT CONSENT FORM FOR PARTICIPATION IN HUMAN RESEARCH AT MONTANA STATE UNIVERSITY- CONTINUED

The details of this study have been approved of by both the Montana State University and the Bismarck State College Internal Review Boards. If you have any further questions you'd like to discuss, please feel free to contact me, JoDe Knutson-Person, at jode.knutson.person@bsc.nodak.edu or 224-5540. If you have further questions about the rights of human subjects you can contact the Chair of the Institutional Review Board, Mark Quinn, (406) 994-4707 [mquinn@montana.edu].

Thank you, in advance, for involving your child in what I hope becomes an ongoing relationship between Jeannette Myhre Elementary students and Bismarck State College students.

Sincerely,

JoDe Knutson-Person

Chemistry Instructor

Please return this portion only if you would NOT like your child to participate in this project.

I, ________________, would NOT like my child, ______, to participate in this final capstone project for JoDe Knutson-Person.

________________________ ____________

Signature **Date**

APPENDIX J

CONSENT FORM FOR COLLEGE STUDENT

Appendix J
Consent Form For College Student

December 14, 2010

SUBJECT CONSENT FORM FOR
PARTICIPATION IN HUMAN RESEARCH AT
MONTANA STATE UNIVERSITY

Dear Student,

You are being asked to participate in a research study of *The Effects of Science Outreach by College Students with Elementary School Children.* This study will consist of seven to twelve college students participating in an outreach project for service learning credit. During this project, this group of college science students will be going into a kindergarten and fifth grade elementary classroom to activities that intend to increase awareness of science as well as empower the elementary students to look toward college being part of their future goals.

This project will consist of a group of science students, monitored by me and the classroom teacher will go into a kindergarten and fifth grade classroom about once a month to do hands-on science activities which coordinate with their science curriculum. The school counselor will train this group on how to work appropriately with the students and respond accordingly to questions. I will also have a guest come in to discuss career opportunities we can link into each of the activities we share with the elementary students. When you are working in the classrooms, you and another student will work with a small group of elementary students (3-4) doing the hands-on activities, discussing the scientific concepts involved the chosen activities and how interest in these topics can lead to very fulfilling career goals. Toward the end of the school year, we will work together to either provide a school assembly or science fun day to celebrate our time together.

This project will take place from January through May of 2011. It will require a minimum 32 hours of time spent to earn one credit hour of service learning credit (offered tuition free with appropriate approval). The time spent will be rather flexible with school visits probably on Tuesday afternoons toward the end of each month.

Participation is voluntary and will include some amount of data collection on my part. You can choose to not answer questions you do not want to answer in the *PreOutreach and PostOutreach Questionnaires* without penalty to your grade or class standing. Participation in this project will also include journal writing activities, preparation work and wrap-up discussions. You can stop participation in this project at any time.

Only group analysis will be involved in the final documentation. There will be photos/videos taken of these group activities and random brief interviews of students that may become part of my final presentation of which, any identifying information will be edited out.

There are no foreseen risks involved with this project. Any information collected from this study will be kept confidential and your identity will be protected at all times unless you personally request otherwise.

SUBJECT CONSENT FORM FOR PARTICIPATION IN HUMAN RESEARCH AT MONTANA STATE UNIVERSITY- CONTINUED

The details of this study have been approved of by both the Montana State University and the Bismarck State College Internal Review Boards. If you have any further questions you'd like to discuss, please feel free to contact me, JoDe Knutson-Person, at jode.knutson.person@bsc.nodak.edu or 224-5540. If you have further questions about the rights of human subjects you can contact the Chair of the Institutional Review Board, Mark Quinn, (406) 994-4707 [mquinn@montana.edu].

Thank you, in advance, for being involved what I hope becomes an ongoing relationship between Jeannette Myhre Elementary students and Bismarck State College students.

Sincerely,

JoDe Knutson-Person

Chemistry Instructor

AUTHORIZATION: I have read the above and understand the discomforts, inconvenience and risk of this study. I, ______________________________ *(name of subject),* agree to participate in this research. I understand that I may later refuse to participate, and that I may withdraw from the study at any time. I have received a copy of this consent form for my own records.

Signed: ____

Investigator: ____

Date: ____

APPENDIX K

SUMMARY OF SCIENCE OUTREACH ACTIVITIES

Appendix K
Summary of Science Outreach Activities

Permanent Rainbows and Polage

Rainbow Glasses (a.k.a. Goober Glasses)

Kindergarten- -look through diffraction grating disc at the lights, out the window, etc.

-Rainbow Fish- Tattle Tale, by Sonia Sander (Part of the collection of the Adventures of Rainbow Fish collection) is read—a story about friendship and cooperation during a science experiment.

5th grade—demo spectrum tubes, notice spectral lines.

Spectral lines are unique to each element and are used to identify elements including how scientists discovered stars are composed of hydrogen and helium.

(When the elementary students are done looking through glasses, hand out diffraction grating discs for a take-home.)

Figure 8. Diffraction Grating Disks Photo.

Rainbow Prints (from Exploratorium and Chemistry in Art materials)

- Shallow bowl
- Water
- Scissor
- Construction paper (dark colors work best)
- Bottle of clear nail polish
- Paper towels or newspaper

1) Fill the shallow bowl with about an inch of water.
2) Cut construction paper into pieces.
3) Put one piece of the construction paper into the water. Press it down until it is completely wet. If it floats to the top of the water, it's okay. If the paper bleeds (or comes off) that's okay too.
4) Take the nail polish and touch just the tip of the brush to the water. You should see a film floating on the top of the water, if you don't, add one more drop of nail polish).
5) Very carefully and slowly lift the paper out of the water, under the film. Tilt it a little so the water runs off. Gently lay it onto a paper towel or newspaper to dry.
6) If doing more than one, make sure the polish film has been removed before doing a second sample.
7) When the print is dry, pick it up and hold it under a bright light.

Tilt the paper until you see the brightest colors. The color of print will be a little different with each color paper you use.

Figure 9. Permanent Rainbow Photos.

Polage- (There is a great explanation and extension in Zap Science: A Scientific Playground in a Book by Klutz. Another great resource is www.Austine.com)

- Each student gets 2 polarizing film discs with a clear piece of acetate between them.
- Place multiple pieces of cheap tape on the area covered by the discs—you may want to cut the tape for the students. (Be sure to check the tape to make sure it's "polarizable" prior to doing this activity.) Each student should use 4-10 pieces of tape depending on time.
- Punch through the tape that may have covered the hole in the clear plastic piece.
- Assemble using a brad
- Spin one of the polarizing discs while holding the piece up to the light and notice what happens.

WHAT'S GOING ON???

Incoming light come in all wavelengths (colors of the rainbow) from all directions (absolute chaos!)

The first polarizing filter allows only light through in one direction.

The tape layers each bend the light in a different direction.

The remaining light is then filtered through the second polarizing filter and only one direction of wavelength is allowed through.

Spinning the polarizing disc changes the direction of the light allowed through.

Check www.Austine.com for some AMAZING art using this technique.

This is the punch we used. Put the acetate between two sheets of paper to lessen frustration using it with the acetate (transparency) sheets.

Use a very small hole punch to punch a hole in the center of the polarizing filter discs and the acetate sheet so a small brad (used for scrapbooking) can be used to put everything together.
Turn one disc when done to see the polage "magic."

Figure 10. Polage Photos and FYI’s

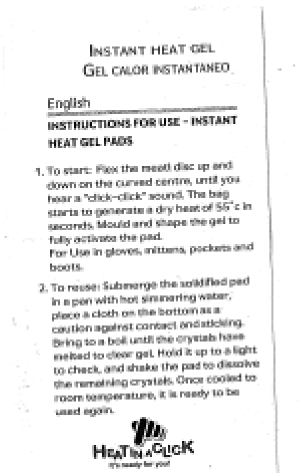
You can just use polarizing filters and square cut transparency sheets with tape to make it easy. There are a LOT of artistic and scientific extensions you can do with this activity!

Heat in a Click and Ziploc Chemistry

Introduction:

- Give a brief definition of physical and chemical changes. Explain to students signs of physical changes and reactions.
- Show students how to use the measuring tools: graduated cylinder, 5mL spoon (1tsp), 1mL beral pipet.

Heat in a Click pad


INSTANT HEAT GEL
GEL CALOR INSTANTANEO

English

INSTRUCTIONS FOR USE – INSTANT HEAT GEL PADS

1. To start: Flex the metal disc up and down on the curved centre, until you hear a "click–click" sound. The bag starts to generate a dry heat of 55°c in seconds. Mould and shape the gel to fully activate the pad.
For Use in gloves, mittens, pockets and boots.
2. To reuse: Submerge the solidified pad in a pan with hot simmering water, place a cloth on the bottom as a caution against contact and sticking. Bring to a boil until the crystals have melted to clear gel. Hold it up to a light to check, and shake the pad to dissolve the remaining crystals. Once cooled to room temperature, it is ready to be used again.

HEAT IN A CLICK

Figure 11. Heat in a Click Instructions and Photo.

<u>WARNING</u>: Kids LOVE this!!! It's quick and fun… especially appreciated if it's cool/cold outside ☺.

FAQ

What is in the pad?

The pad contains water and food grade sodium acetate (a form of salt) and a stainless steel disc.

How is the heat produced? (This is a saturated sodium acetate solution demonstration that every student can hold in his/her hands.)

Flexing the metal disc in the liquid creates a chain reaction causing the pad to crystallize. This crystallization ALWAYS occurs at a temperature of 130 degrees F / 54 C. Once activated, the pad has available to it a predetermined amount of energy. It will use this energy to increase the temperature of the pad to 130 degrees F / 54 C and use whatever is left to maintain that temperature. This ability to produce heat for a period of time is accomplished because all of the liquid does not crystallize immediately. Molecules that were not required to heat the pad to its maximum temperature will remain liquid, and crystallize as required, to maintain the maximum temperature.

How do you re-use the pad?

Once the pad has given off all of its heat it will remain in its crystallized state until it is recharged. This is accomplished by placing the crystallized pad in boiling water for 5 to 10 minutes (depending upon the size of the pad) until all of the crystals are melted. Once completely liquefied, remove the pad from the water and store it until you wish to use it again. The pad should remain liquid as it cools. If crystals form as the pad cools it has not been boiled long enough. Place the pad in boiling water again until all the crystals have dissolved and the pad is completely clear.

How long does the heat last?

Smaller pads will be very hot for the first 30 minutes and then will gradually cool down, while larger pads will be hot for the first hour and then start to cool down.

How many times can the pad be used?

There is no limit as to the number of times a pad can be used.

For this and more information, see http://cgi.ebay.com/10-New-Heat-Click-Reusable-Hand-Pocket-Warmer-Pads-/220708058649?pt=LH_DefaultDomain_0&hash=item336339b619 or http://webserver.dmt.upm.es/~isidoro/bk3/c07sol/Hot%20pads%20and%20cold%20pads.htm or search for "reusable hot packs."

Ziploc Chemistry

Materials needed:

Baking soda, sodium bicarbonate, $NAHCO_3$
Ice Melt, Calcium chloride, $CaCl_2$
Phenol Red solution (You could also use red cabbage juice indicator.)
2 plastic teaspoons
2- 10mL containers
1- 1mL beral pipet
Zip-loc bags, quart size (not the cheap ones—they are more likely to leak)
(It would be good to do this on absorbent paper or in a tray—the indicator will stain desks or tabletops.)

Safety Precautions:

Goggles must be worn.
Calcium chloride absorbs water from the air. Keep the container tightly sealed when not in use.

Disposal:

All solutions can be rinsed down the sink.

Procedure:

1. Measure 10mL of water into the vial to be used as a measuring tool.
2. Place 1 spoonful of baking soda into one corner of a quart-size Ziploc bag.
3. Place 2 spoonfuls of calcium chloride in the opposite corner of the same bag.

4. ***Record any observations. (What do you notice?)***
5. Measure 10mL of the phenol red solution into the marked plastic vial.
6. Place the vial UPRIGHT in the Ziploc bag, carefully squeeze most of the air out of the Ziploc bag, and seal it.
7. Spill the vial of phenol red solution and mix the contents of the bag.
8. ***Record any observations.***
9. ***Extension: Determine which component was "at fault" for each observation. Try the following experiments. Record your observations after each experiment.***
    - ***a.*** *Baking soda:*
        - ***i.*** *Add 2 spoonful of baking soda and 5mL of water to a Ziploc bag.*
        - ***ii.*** *Mix, observe, and record.*
    - ***b.*** *Calcium chloride:*
        - ***i.*** *Add 1 spoonful of calcium chloride to another Ziploc bag.*
        - ***ii.*** *Mix, observe, and record.*
10. *Which observations from your first Ziploc reaction line up for each of the components test*

A foldable is given to each student as a lab notebook as shown on the next page.

Here's the directions for folding a foldable for this activity.

http://www.youtube.com/watch?v=KEXYqRit9JY&feature=related

- *One page lists the materials.*
- *One page gives the procedure.*
- *The remaining pages are for recording observations.*
- *(This will need some guidance if lab notebooks aren't used. You should stop after each step and take time to have the elementary students make observations.)*

ZIPTOP BAG CHEMISTRY

Materials: 3 ziptop baggies
2 tsp. calcium chloride (ice melt)
4 tsp. sodium hydrogen carbonate (baking soda)
15 mL water
Graduated cylinders
1 mL or dropper full indicator solution (red cabbage juice)

PROCEDURE:

1. **A.** Mix 4 tsp. sodium hydrogen carbonate and 2 tsp. calcium chloride to the Ziploc bag. Hold baggie to have powder on one side and pour 30mL of water on the other side.

   B. Squeeze out excess air and seal the bag. Gently shake bag to mix and Look, Listen and Feel; then record observations

2. Mix 4 tsp. sodium bicarbonate and 2 tsp. calcium chloride in another Ziploc bag. Hold bag to have powder on one side and pour 15mL of water and 1mL of indicator solution on the other side. Repeat step **B** above.

3. Repeat procedure 2, with 15mL of water and 2mL of indicator solution.

Ziploc bag #1

Ziploc bag #2

Ziploc bag #3

Magnet Play and Observation

Introduction:

Kindergarten:

- History of magnets briefly gone over as a mini-cultural diversity activity. See the following website: History of Magnets: http://www.fmdowntown.com/uploads/2011_Downtown_Street_Fair_MAIN_MAP_for_web.pdf
- How magnets work was simply described as an analogy to students standing in a line—they all face the same way (like the domains of a magnet) rather than in an unorderly manner. (Kindergartners practice getting in a line a lot—they should get this.)

Fifth grade: College students described what a magnet is and guided the elementary student exploration.

Activities taken from Usborne Science Activities-- Science with Magnets and Exploratorium activities. (I would recommend using many available types of magnets—cow magnets are pretty wimpy and incredibly non-impressive. Try neodymium-iron-boron (NIB) for strength. We super glued small ¼" NIB magnets in a beral pipet with the end cut off filled with colored sand to make magnetic wands.)

Figure 12. Magnetic Wands.

Magnets

- *What's a magnet?*
    - *A material—made up of many parts called domains. Each domain is like a mini-magnet. They all line up and point the same way.*
    - *The domains in a magnet are all facing the same way. This makes a magnet have "poles" we refer to as north and south poles. The south pole of a magnet is attracted to the north pole of another magnet.*
    - *The domains of any metal that sticks to a magnet are jumbled up in different directions until put near a magnet. The magnet can make the domains line up and become a magnet.*

Figure 13. Domains of a Material Before and After Magnetization.

- *Playtime—Kindergarten*
    - *Is it Magnetic?*
      What materials stick to magnets?
        Make a pile of the common items that are magnetic and those that are not.
        Look at characteristics of those materials that are magnetic and not.
          Metal, plastic, cork
          Brass, copper, iron

    - *Do you feel the attractive forces?*
    - *Do you feel the repulsive forces? How far can the magnets pull?*
    - *Use a magnet to add facial hair to the funny face*
    - *Matchboxes*
    - *How many notecards can you get between 2 magnets?*
- *Playtime—5th graders*
    - *See above*
    - *Floating clips*
    - *Electromagnet- demo*

Anodizing Niobium

Introduction:

- The fifth graders have a concept of iron, oxygen, and rust. Discuss other reactions with oxygen and relate the niobium oxide layer to a different "type" of rust. Also discuss how the electricity from the batteries is used to split the water molecule—note the hydrogen gas on the anode and that the oxygen is reacting with the niobium giving an oxide on the surface of the metal that refracts the light (full circle discussion to the diffraction grating) into the colors of the rainbow depending on the thickness of the oxide layer—THERE IS NO COLOR IN THIS LAYER!
- The color is analogous to the rainbow effect of a bubble, irridescent butterfly wing, or oil slick.
- The following information was provided to the college students and elementary teachers for discussion with the elementary students:

ANODIZING NIOBIUM

(Information from http://reactivemetals.com *and Chemistry in Art course.)*

Anodizing is a fast & simple electrical process that generates very thin transparent oxides, "rusts," on the surface of the reactive metals. This film generates interference colors, "rainbow-like patterns," similar to the ones you see on an oily wet street. There are no pigments or dyes. The process is done by the use of running a current, from batteries, through a solution that can conduct electricity. Colors can be controlled and laid down individually by using masking techniques.

Interference colors

The colors produced by these metals are known as interference colors. There are no pigments or dies involved. They are generated by a transparent oxide film grown on the metal surface. The colors develop when part of the light striking the surface reflects and part pass through the film to reflect off the metal below. When the delayed light reappears and combines with the surface light waves they may either reinforce or cancel. This generates a specific color. The thickness of the oxide film dictates the color. In nature these colors can be found in the eddies of an oily wet street and in the iridescent colors of some insects.

Coloring

Coloring can be achieved in two ways; thermal oxidation and electrolytic oxidation (anodizing). Today, we will be anodizing. Through electron excitation, the metals react with oxygen to form a thin transparent film. Anodizing is infinitely more predictable and is the only effective way to color niobium.

The colors produced appear in up to five repeating orders. Most of the current jewelry is produced with the first two orders. All the colors of the light spectrum are not produced. True red and forest green are not generated. It is not the oxide itself that is perceived by the viewer but its effect on light.

Although harder than the parent metal, the extreme thinness of this oxide dictates that it is not a strong wearing surface. Bracelets, belt buckles, rings and items that normally receive heavy abrasion should not be considered unless the metals are protected by other design elements.

Anodizing most closely resembles standard electroplating. When a reactive metal is suspended in a electrolytic bath as an anode(+) and current is passed through the bath, oxygen is produced at the anode surface. This oxygen reacts with the metal to form a thin oxide film that generates colors. The transparent oxide increases in thickness in relation to the amount of voltage applied. At any given voltage, the oxide will grow to a specific thickness (i.e. color) and stop, having reached a stage where current will no longer pass. This phenomenon of voltage controlled growth means that the color is also voltage controlled.

An area of oxide produced with a high voltage will not pass current from a lower voltage. In other words an area anodized at 60 volts will not need masking when an adjacent area is anodized to 40 volts. It follows that multiple anodizing processes should proceed in decreasing voltages. Working in descending order will save masking and generate fewer errors.

While oxygen is generated at the anode(+), hydrogen is formed at the cathode(-). Titanium and stainless steel make most convenient cathodes. We will use a stainless steel screw. This process does not have much throwing power and it is necessary to have a cathode equal to or larger than the anode.

The electrolytic solution can be almost any liquid capable of carrying current. Such diverse solutions as Coca-Cola, Sparex, sulfuric acid, ammonium sulfate (fertilizer), magnesium sulfate (Epsom salts), trisodium phosphate, dish detergents and even wine will work. Recommended here is a solution of 3 to 10% by weight trisodium phosphate (T.S.P.) in solution with distilled water. The percentage of chemicals in the solution will determine to some extent the length of time for the desired reaction to be completed. Slowing the reaction can be achieved by lowering the concentration of chemical in solution.

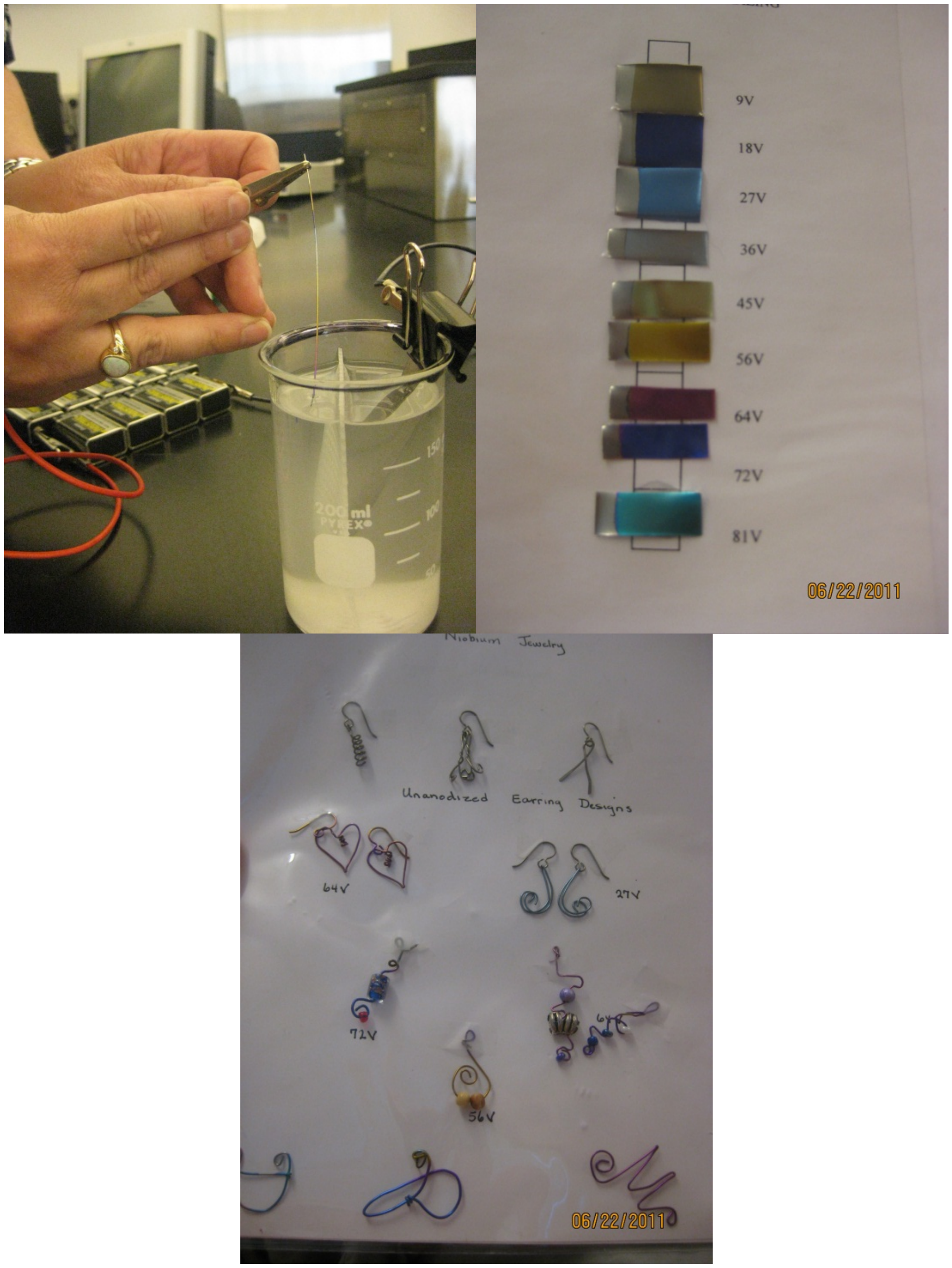


Figure 14. Anodizing Niobium Example Photos.

Sunprints

This is an alternative photography technique used in my chemistry in art course. Here's a link with the details of the science and many ideas and extensions to incorporate art http://www.sunprints.org/?page_id=11. Basically, a combination of chemicals is applied to paper or fabric. This mixture is photo reactive (reacts with light). It is initially a yellow color which changes to indigo upon exposure to light.

FYI— We did our activity on a stormy day so we had to use overhead projectors instead of going outside to use the sunlight for the reaction. This works really well with one consideration… depending on the technological advancements of the school—students may need additional time to be amazed at the overhead projector. Our kindergarten students had NEVER seen them and were amazed at the shadows they could throw on the wall as well as the rainbows formed. Use of the projector also saves time since bodies aren't moving inside and outside and back.

We talked about how some things react with light and how this is an older form of photography. We also made the sunprints incorporate their school logo, moto for the *Hope for the Future Program,* and their highschool graduation date.

As a final piece, we traced around their hands and my college students and I did a large cyanotype on fabric with the handprints for each class then, added a light yellow binding to represent the pre-reaction color of the cyanotype mixture—this cyanotype was given to the elementary classroom teachers as a thank you gift.

Figure 15. Sunprints and Cyanotype Photos.