

# **Effectiveness of the Integration of a STEM career awareness program in a regular Geology Class in Increasing Awareness and Knowledge of Geoscience**

*Geizi E. Llanes*

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Science, Technology, Engineering and Math (a.k.a. STEM) careers and occupations have a projected wage growth greater than the median of all occupations, and the demand for these jobs is growing faster than the average job growth in the past ten years. Despite the fact that STEM jobs pays higher than the other occupations, there are as yet very few graduates in STEM-related fields and, significantly, there is low interest from graduating High School students in pursuing college-level geoscience or Earth science courses.

A Geo – STEM Career Awareness Program was implemented in the regular geology class of Piedra Vista High School in Farmington, NM, with the goal of increasing the interest and knowledge of geoscience careers among the participants. A pre- and post-program survey was given to the student participants - with parental consent - and the responses were analyzed; the responses showed a significant increase in knowing what the acronym STEM stands for, shifting their belief where STEM development is critically important from Technological Advancement to Educational Reform and identifying that STEM development is critical to our state and our country.

The results identified in this study suggest that integrating similar career awareness programs in geoscience classes (Geology, Earth Science, Environmental Science, and related fields) may increase knowledge and awareness of these careers and therefore offer potential college-level career-paths to students who would otherwise not have been introduced to such opportunities.

***Effectiveness of the Integration of a STEM career awareness program in a regular Geology Class in Increasing Awareness and Knowledge of Geoscience***

By:

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Also deserving of recognition is my building Principal at Piedra Vista High School Mr. Dave Golden and our school Librarian Mrs. Margaret Sartin for all the support.

And most of all, to my two girls: Sephora and Ruth, for the never-ending support and encouragement as well to Steve for all his understanding and love.

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## Introduction

Science, Technology, Engineering and Mathematics (STEM) is one of the fastest emerging educational approaches around the world. Mastery of these four fields gives rise to the most in demand and highest paying jobs currently and in the future. Ironically, The United States Department of Commerce predicts that by 2018, “our country will have 1.2 million unfilled jobs in STEM fields because the workforce may not possess the necessary skills or interests” (Bertram, 2014).

This educational approach was first coined by the National Science Foundation (NSF) in the early 2000 which they have generously funded since then (Dugger, 2010). Unfortunately, STEM careers and disciplines have not been very attractive to American students. There has been documented rise and fall of STEM as career goal and significant decrease in enrollment in STEM discipline among our students is expected to create a shortage of scientists and engineers in the US workforce (Becker & Park, 2011). Because of this, there is a huge demand in understanding and applying effective efforts on how to implement STEM in the US schools.

The problem is this: Student Interest in STEM careers is low. Why? It has been noted that young students shows interest in STEM subjects, but “roughly 40% of college students planning to major in Engineering and Science end up switching to other subjects” (Adkins, 2012). In addition, 60% of the nation’s students who begin High School interested in STEM, change their minds by graduation according to a report released by STEMConnector and college planning service by My College Options (Morella, 2013). Being an educator in the secondary schools for over 16 years, it could be pointed to

different reasons. One of them is that educator themselves also lack the exposure to methodologies on how to incorporate STEM programs into their curriculum. With the new teacher evaluation system in selected states across the country, educators of core classes (Math, Language Arts and Science) are forced to teach what is only being tested, and therefore lacks the time to incorporate STEM career awareness programs into their classes. Most students have the idea of STEM when they leave Junior HS but ACT, the college readiness assessment testing company, points a gap between the level of students' expressed interest in STEM areas and their intentions to pursue STEM careers (Alphonse, 2014). There is a huge discrepancy between interest and intention and therefore follow up and support of these interests to lead into intentions is the secondary factor of the low number of students pursuing STEM related careers after secondary education.

“Studies show children exposed to STEM educational resources at a very young age perform better in Science and Math than students who are not” (Fudge, 2013). More and more workers need the necessary technology skills in order to be hireable (The Center for Education Policy Analysis, 2008) and to be able to acquire such skills, High School graduates need to have an exposure to Science, Technology, Engineering and Math classes and/or classroom activities and know how these four blend together in creating one strong and solid career.

Most students are also unaware of the fact that those who took home degrees in STEM disciplines are “paid significantly better – averaging \$65,000 a year compared

with” a \$49,500 for graduates with other degrees (The Associated Press, 2014). Since Piedra Vista High School (the setting of this study) is located in the coal capital of the South West, it is most important that students should know that STEM jobs associated in Oil and Gas, healthcare such as nursing and medicines are also the ones that stays longer at the top of the pay scale (Dil, 2014). Usually, mastery of the regular curriculum is believed to be necessary to better understand the objectives of a STEM career awareness program. However according to Claymier, the importance of STEM integration in the regular curriculum has seen to contribute to the better understanding of regular classes (Claymier, 2014).

## **The First Cohort**

The Setting of the study is at Piedra Vista High School, which is one of the three High Schools of Farmington Municipal Schools located at the North West tip of the state of New Mexico within the Four Corners Region. It is a regular secondary public school that as of the end of the school year 2015 – 2016, serves about 1,400 students of different ethnicities: Hispanic (30.1%), Caucasian (41.4%), Native Americans (26.5%), Black (1%) and Asian (0.8%). The school is located in one of the most geologically rich resource region in the state of New Mexico which has two large coal-fired electric power plants: the 2,100-megawatt Four Corners and the 1,643-megawatt San Juan which are both supplied by local coal mines: the Navajo and San Juan mines. Electricity from New Mexico is distributed to consumers in Texas, Arizona, California, and Utah, as well as New Mexico and generates most of the highest paying jobs for the local and surrounding communities. The area also boasts spectacular Geologic outdoor destinations in the Colorado Plateau (Shiprock - Tsé Bit'a'í, Hogback - Tse Daa K'aan, the ghostly alien – like Hoodoos of Bisti Badlands, etc.) for visitors and tourists to witness and experience that adds income to the community.

The Geology Class of 2015 – 2016 for Semester 1 comprises of upperclassmen grades 11 – 12, 38 % of which are seniors. Most students who registered for the Geology class admitted that they have no knowledge and/or interest on any Geoscience – related careers and that the reason why they are in this class is either to complete their final Science credit which is a graduation requirement or they just need an elective class to complete the 24.5 (for class of 2016) or 25 (for the class of 2017) credits required for by New Mexico Public Education Department (NMPED) for High School completion. About 30% of the Senior

students enrolled in the class failed general to honors Chemistry during their junior year and most of them were advised by their guidance counselors to take Geology class because it is a “relatively easier class” compared to Chemistry or Physics. This reason and the fact that geoscience courses are not required high school classes like Physical/Integrated Science and Biology (Schmidt, 2013) adds to the significant decrease of students interested in pursuing this degree.

## **Program Description**

The program aims to integrate STEM career awareness activities in a regular Geology Class to increase understanding and knowledge of STEM and its importance to Geoscience and its careers. The null hypothesis for this study is that both sample populations will be (students before and after exposure to the Geo – STEM career awareness program)  $P_1 = P_2$  and that the acceptable hypothesis is that  $P_1 \neq P_2$  where  $P_2$  shows a significantly higher understanding of STEM and Geo – STEM careers.

Although Geology is not a “tested” course in the state of New Mexico (it has no required End of Course Assessment unlike Biology, Chemistry, Physics, Anatomy and Physiology, Environmental Science and Physical Science), the class still follows a pacing guide in which all the topics need to be covered before the end of the school year. To provide enough time to cover all the topics in the pacing guide, Monday to Thursday is typically for the regular Geology topics with a little to some integration of Geology careers at the end of a unit. Monday to Wednesday are lectures, labs, completion of lab reports, research and other activities on regular Geology class; Thursday is for quizzes or assessments while Fridays are provided for the Geo – STEM activities.

Unlike other programs implemented in the middle and high school setting with similar objective of increasing awareness and knowledge of Geosciences such as GeoX, Pathways, GeoFORCE, iGEO, iGIS, and G – Camp in some Texas schools (Houser, et.al, 2015); Buffalo Geosciences Program (BGP) and NSF – Opportunities for Enhancing Diversity in the Geosciences (OEDG) (Blake, et.al. 2015), NSF – REU in certain NY schools (Blake, et.al,

2013), the EDGE Program (Connor and Prakash, 2008) and the Rural Alaska Honors Institute (RAHI) program (Hanks, 2007), the program that was implemented at Piedra Vista High School in Farmington for the School Year 2015 – 2016 does NOT: (1) target the minorities to diversify underrepresented minority (URM) groups; (2) require College Board Preliminary Scholastic Assessment Test (PSAT) or Scholastic Assessment Test (SAT) scores; (3) only target students with Math, Science, AP science/math interests; (4) require a rigorous application process; and (5) specifically serve upperclassmen that has a high interest on pursuing a geoscience career after high school. Since students register in this class for various reasons, the integration of a Geo – STEM Career awareness program was explained and clarified to them as a part of the curriculum. However, responses to the pre and post survey before the implementation of the program is voluntary and solely based on whether the students and parents agreed to be part of the study.

A list of the activities that the students with parental consent are described below in Table I.

Activity	Department/Topic	Brief Description and Objectives
Methods of a Scientist	Scientific Method Science (Geologist) Skills	Identifying the importance of Geoscience to world current events and issues  ➔ With Guest Speaker from Energy, Minerals and Natural Resources Department, OCD District III, Katherine Pickford (Geoscientist) ➔ Guest speaker discussed and presented ' <i>Careers in Geology</i> '
Classification of Maps	Mapping and Geography	Describe the different classification of Maps and the importance of Math in Map reading.  ➔ Work stations on reading different types of maps applying basic Math and Scientific Method ➔ Exploring Google Maps and its applications
Topographic Map Modeling	Mapping, Geography and Modeling	Gain better understanding of a topographic map, what it represents, information it provides and how it is used.  ➔ Students constructed a cross-sectional elevation diagram from elevation data on a topographic map, and built a three dimensional landform model from a topographic map of the Rio Grande which includes the Northern part of White Rock Canton and Otowi Peak (east of Los Alamos)  (Lesson was adapted from NM Bureau of Geology & Mineral Resources through the Rockin' NM Teachers Summer Program)  ➔ Presentation of the finished 3D landform model ➔ Identifying the importance of knowing how to interpret data, measurement, plot data on a graph and the Scientific Method.
GPS	Geography	Understanding of global positioning systems (GPS) its history and importance of Science,

		<p>Technology, Engineering and Computers as well as Map in data interpretation and programming</p> <p>➔ Students played with Netlogo programs on mapping and satellite images.</p>
3D Topographic Map	Geology, Landforms, Mapping, Computer Programming	<p>Experience high – quality interactive and physical models and demonstrations of topography using the Augmented Sandbox Technology at San Juan College, Farmington NM.</p> <p>➔ Create landscapes through a face – time guided activity with the NM Bureau of Geology &amp; Mineral Resources c/o Susie Welch and Talon Newton</p> <p>➔ Identify importance of knowledge in computers, computer programming, Math and Science in this technology</p> <p>➔ Identify the importance of the interactive model to predicting floods, earthquakes and volcanic eruption.</p>
Convection Current Lab	Earth (Plate Tectonics) and Atmospheric Science	<p>Understand the convection as a means of heat transfer by conducting an interactive lab where students will witness and describe the factors that affect convection currents.</p> <p>➔ Use of observational skills and scientific method for data analysis</p>
3D Model making of the three major classification of plate boundaries	Geology and Geography	Create a 3D model of the three main types of plate boundaries and the 3 sub types of convergent plate boundaries
Mineral Classification Lab	Geology and Geography	<p>Hands on and Interactive Lab on Mineral ID and Classification using ID keys</p> <p>➔ Identify STEM careers that enable us to get important minerals as a raw material for most stuff we use.</p> <ul style="list-style-type: none"> <li>- Industry</li> <li>- Construction</li> <li>- Medicine</li> <li>- Etc.</li> </ul>

<p>School visit by a representative of Merrion Oil and Gas Company in Farmington, NM</p>	<p>All</p>	<p>Representative Jacob Sharpe from Merrion Oil and Gas presented the importance of Science in Math in the Oil and Gas Industry of the Four Corners.</p> <ul style="list-style-type: none"> <li>➔ Representative modeled a mathematical problem needed to determine where to drill a well for natural gas</li> <li>➔ Showed the importance of Math and Data Analysis skills in determining where to drill a well for energy sources</li> </ul>
<p>School visit by a representative from Halliburton, Farmington Office</p>	<p>All</p>	<p>Representative Clint Lehar from Halliburton presented the importance of Science (particularly Chemistry), Math (Algebra, Trigonometry &amp; Geometry) and knowledge in computers and engineering in Hydraulic Fracturing (Fracking) industry.</p> <ul style="list-style-type: none"> <li>➔ Demonstration of combining chemicals used as a fracking fluid and reversing the process.</li> <li>➔ Discussion of the speakers' college Science and Math classes</li> <li>➔ Work experiences prior to their current jobs</li> </ul>
<p>Igneous Rock Classification Lab</p>	<p>Geology and Geography</p>	<p>Hands on and Interactive Lab on Igneous Rock ID and Classification using ID keys</p> <ul style="list-style-type: none"> <li>➔ Identify STEM Careers that makes various types of Igneous Rock available for our use. <ul style="list-style-type: none"> <li>- Industry</li> <li>- Construction</li> <li>- Medicine</li> <li>- Etc.</li> </ul> </li> </ul>
<p>School visit by a Natural Resource Specialist from Navajo Nation Environmental Protection Agency (EPA)</p>	<p>Geology, Geography, Navajo agricultural practices</p>	<p>Representative Fred Johnson from NNEPA explained the importance of STEM in many geologic and hydrologic issues in the Navajo Nation:</p> <ul style="list-style-type: none"> <li>➔ Showed a model of a healthy and an unhealthy watershed in the Navajo Nation due to negligent practices</li> <li>➔ Discussed the current watershed conditions in the Navajo nation</li> <li>➔ Identified key factors why erosion is fairly common in certain areas in the Navajo Nation (natural and anthropogenic –</li> </ul>

		caused)
Visit to Navajo Mine thru the bhpBilliton company	All	Class was able to visit the Navajo Coal Mine thru the collaboration with Manager Dan Ware: → Geology of a coal mine (coal beds, beddings, cross bedding, graded bedding) → Careers in a coal mine industry → College courses and skills needed to be able to work in a coal mine industry

In addition to the summarized description of each of the activities in the Geo – STEM Career awareness program, guided research activity on careers that require Science, Technology, Engineering and Math at the end of each unit was also implemented (See Appendix 1).

Below (Table II) is an example copy of a week – long lesson plan showing one of the ways on how the STEM – career awareness program is integrated in the Geology pacing guide (followed by an actual screen shot from my web – page – Figure 1):

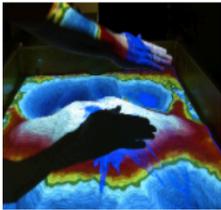
Table II. A sample week – long lesson plan on Mapping:

**Week of 9/21/15 to 9/25/15 - Class**

Date	Goals/Objectives	ETs/Lessons/Activities /Assignments	New Mexico Standards & Benchmarks
<b>Monday 9/21</b>	1. Students will continue on their mapping activity from last week. 2. Individual Assessment on GPS Technology and its uses	1. Students will continue on their mapping activity from last week. 2. Review GPS concepts using notes and this website: Students will continue on their mapping activity from last week. <b>Use this link for review:</b> <a href="http://dpipwe.tas.gov.au/Documents/Worksheet%201%20-%20How%20GPS%20Works.pdf">http://dpipwe.tas.gov.au/Documents/Worksheet%201%20-%20How%20GPS%20Works.pdf</a> 3. Quiz on GPS	I.I.I.3 - 4 I.I.III.1 II.III.II.4

		4. Completion of other projects that has not been submitted or completed	
<b>Tue3day 9/22</b>	Analyzing NM Satellite Images for: - Average Annual Precipitation - Vegetation - Topography	Collaborative Activity on NM Satellite Images Click the picture below to access the link to the guide for today: <a href="file:///localhost/fcp/::@fc.fms.k12.nm.us.%25237700277:gllanes:Mapping%20NM%20Elevation,%20Precipitation%20and%20Biomes.final.docx">file:///localhost/fcp/::@fc.fms.k12.nm.us.%25237700277:gllanes:Mapping%20NM%20Elevation,%20Precipitation%20and%20Biomes.final.docx</a>  <a href="#">PDF Format of the Activity Paper</a>	I.I.I.3 - 4 I.I.III.1 II.III.II.4
<b>Wednesday 9/23</b>	1. Introduction to Geo STEM program 2. Expectation for the Geo STEM program 3. Introduction to the trip to San Juan College, School of Energy	- Note taking - Ask questions about the STEM program - Expectations on the visit to San Juan College School of Energy	I.I.I.3 - 4 I.I.III.1 II.III.II.4
<b>Thursday 9/24</b>	<b>San Juan College School of Energy visit:</b> 1. Choose one mineral from the exhibit and identify: - Chemical Structure - Elemental Composition - Uses/Importance 2. Work collaboratively on the sandbox technology. 3. Answer questions on mapping using sand box technology	1. Visit to the School of Energy at San Juan College: 2. Play with the San Box Mapping Tool 3. Choose a mineral for research	I.I.I.3 - 4 I.I.III.1 II.III.II.4
<b>Friday 9/25</b>	Assigned tasks	For those who went to the SJC trip yesterday: 1. Finish your paper from yesterday. 2. Do a very short research about the history, uses, importance of Augemented Reality Sandbox - - <i>This information should be WRITTEN on a piece of writing paper and due today!</i>  For those who stayed in campus yesterday: 1. Finish your research assignment from yesterday if you have not turned it in yet. Remember: The location has to be <b>four corners!</b> 2. Do a very short research about the history, uses, importance of Augemented Reality Sandbox - <i>This information should be WRITTEN on a piece of writing paper and due today!</i>	I.I.I.3 - 4 I.I.III.1 II.III.II.4

**Figure 1: A screenshot of the lesson plan on hands – on activity on Mapping from the class website:**

Date	Goals/Objectives	ETs/Lessons/Activities /Assignments	Standards & Benchmarks
Monday 9/21	<ol style="list-style-type: none"> <li>Students will continue on their mapping activity from last week.</li> <li>Individual Assessment on GPS Technology and its uses</li> </ol>	<ol style="list-style-type: none"> <li>Students will continue on their mapping activity from last week.</li> <li>Review GPS concepts using notes and this website: Students will continue on their mapping activity from last week. <i>Use this link for review:</i> <a href="http://dpi.wv.gov/Files/2014/09/2014-2015%20How%20GPS%20Works.pdf">http://dpi.wv.gov/Files/2014/09/2014-2015%20How%20GPS%20Works.pdf</a></li> <li>Quiz on GPS</li> <li>Completion of other projects that has not been submitted or completed</li> </ol>	I.I.1.3 - 4 I.I.III.1 II.III.II.4
Tue3day 9/22	Analyzing NM Satellite Images for: <ul style="list-style-type: none"> <li>- Average Annual Precipitation</li> <li>- Vegetation</li> <li>- Topography</li> </ul>	Collaborative Activity on NM Satellite Images  Click the picture below to access the link to the guide for today:    <a href="#">PDF Format of the Activity Paper</a>	I.I.1.3 - 4 I.I.III.1 II.III.II.4
Wednesday 9/23	<ol style="list-style-type: none"> <li>Introduction to Geo STEM program</li> <li>Expectation for the Geo STEM program</li> <li>Introduction to the trip to San Juan College, School of Energy</li> </ol>	<ul style="list-style-type: none"> <li>- Note taking</li> <li>- Ask questions about the STEM program</li> <li>- Expectations on the visit to San Juan College School of Energy</li> </ul>	I.I.1.3 - 4 I.I.III.1 II.III.II.4
Thursday 9/24	San Juan College School of Energy visit: <ol style="list-style-type: none"> <li>Choose one mineral from the exhibit and identify:                             <ul style="list-style-type: none"> <li>- Chemical Structure</li> <li>- Elemental Composition</li> <li>- Uses/Importance</li> </ul> </li> <li>Work collaboratively on the sandbox technology.</li> <li>Answer questions on mapping using sand box technology</li> </ol>	<ol style="list-style-type: none"> <li>Visit to the School of Energy at San Juan College:                             <ul style="list-style-type: none"> <li>- Note taking</li> <li>- Ask questions about the STEM program</li> <li>- Expectations on the visit to San Juan College School of Energy</li> </ul> </li> <li>Play with the San Box Mapping Tool</li> <li>Choose a mineral for research</li> </ol> 	I.I.1.3 - 4 I.I.III.1 II.III.II.4
Friday 9/25	Assigned tasks	For those who went to the SJC trip yesterday: <ol style="list-style-type: none"> <li>Finish your paper from yesterday.</li> <li>Do a very short research about the history, uses, importance of Augmented Reality Sandbox - - <i>This information should be WRITTEN on a piece of writing paper and due today!</i></li> </ol> For those who stayed in campus yesterday: <ol style="list-style-type: none"> <li>Finish your research assignment from yesterday if you have not turned it in yet. Remember: The location has to be <b>four corners!</b></li> <li>Do a very short research about the history, uses, importance of Augmented Reality Sandbox - - <i>This information should be WRITTEN on a piece of writing paper and due today!</i></li> </ol>	I.I.1.3 - 4 I.I.III.1 II.III.II.4

**Activities/Events:**

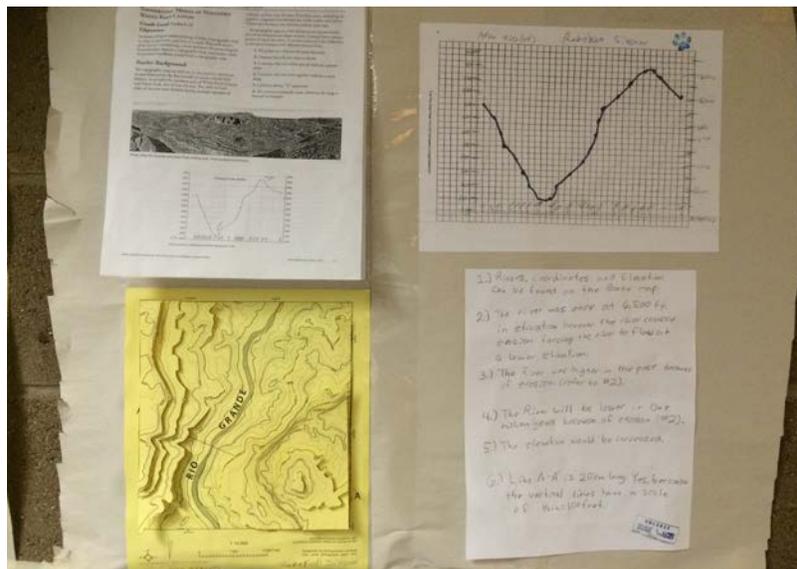
**Methods of a Scientist:**

Guest Speaker from Energy, Minerals and Natural Resources Department, OCD District III, Katherine Pickford visited the Geology class and presented a slideshow of the importance of Math and Science in Geology. There were no hands – on activities for the students during the presentation however, Ms Pickford who has a degree in Geology comprehensively talked about how the understanding of Math and Science took her to

places and landed her to a job that she loves which is working at the EMNRD Aztec Branch office.

*Topographic Map Modeling:*

After 4 days of introduction to maps, identifying and describing the different types of maps as well as their uses and importance to the study of Geology, students constructed a cross-sectional elevation diagram from elevation data on a topographic map, and built a three dimensional landform model from a topographic map of the Rio Grande which includes the Northern part of White Rock Canyon and Otowi Peak (east of Los Alamos. This lesson was adapted from the NM Bureau of Geology & Mineral Resources through the 2015 Rockin' NM Teachers Summer Program with the help and guidance of Susie Welch.



**Figure 2. A cross-sectional elevation diagram from elevation data of the topographic map of the Rio Grande made by one of the teams as a part of the Geo – STEM career awareness program.**

### *3D Topographic Map:*

Students created landscapes through a FaceTime - guided activity with the NM Bureau of Geology & Mineral Resources with the help and guidance of Susie Welch and Talon Newton using the Augmented Sandbox Reality. In this hands – on activity, students went to San Juan College of Energy and the class was split into two equal groups. The first group went around the minerals museum and work on a guided tour by choosing a mineral to research about (See Appendix 2 for the guide paper). The second group did their FaceTime guided activity with the NM Bureau of Geology & Mineral Resources staff using the Sandbox technology. Student created various landscapes such as mountains, valleys, mesas, rivers, depressions and modeled earthquakes and fault lines in the sandbox using their hands. Susie Welch also showed her own models including the three-dimensional landform model of White Rock Canyon, which the students have previously constructed in the *Topographic Map Modeling* activity.



***Figure 3. Students created landscapes using the Augmented Sandbox Technology at the School of Energy at San Juan College in Farmington, NM***

### 3D Model making of the three major classifications of plate boundaries:

After understanding the concepts of Plate Tectonics, Continental Drift Theory, Convection Currents and Plate Boundaries, students were challenged to create their own 3D model of the three major classifications of plate boundaries. Sample models are shown below. Materials are from cardboards to clay, pipe cleaners and boxes. See Appendix 3 for the guide paper.

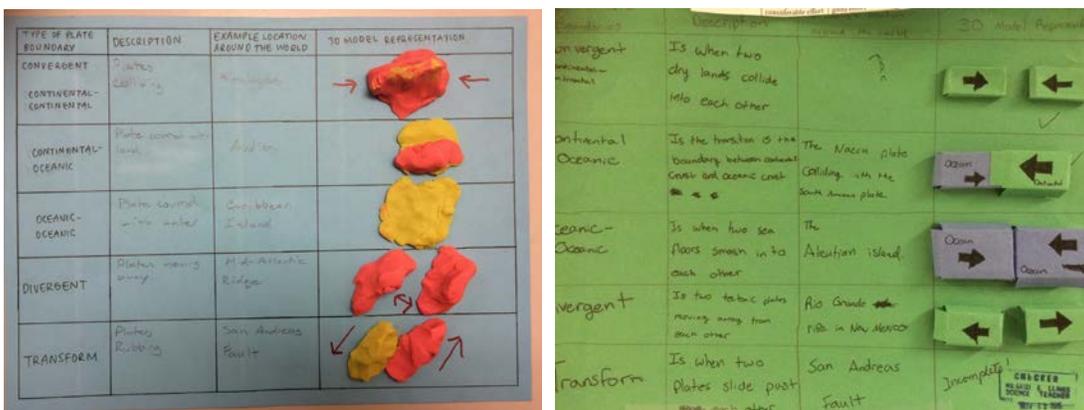
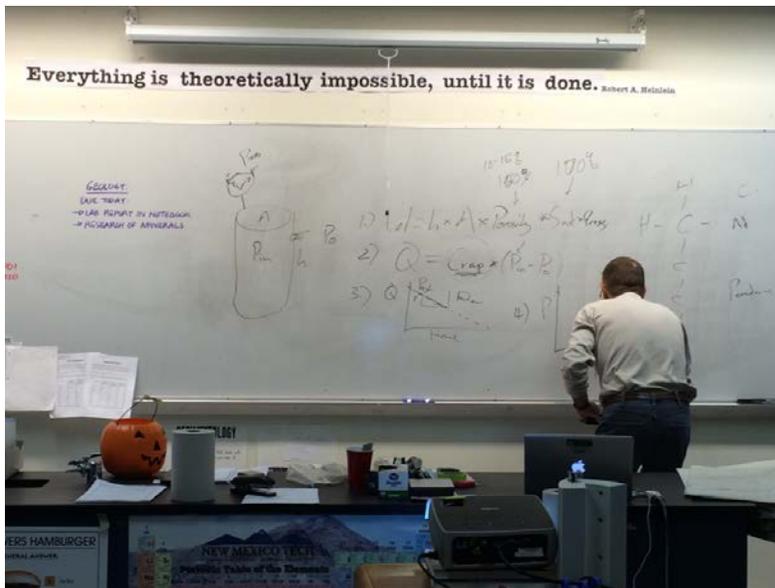
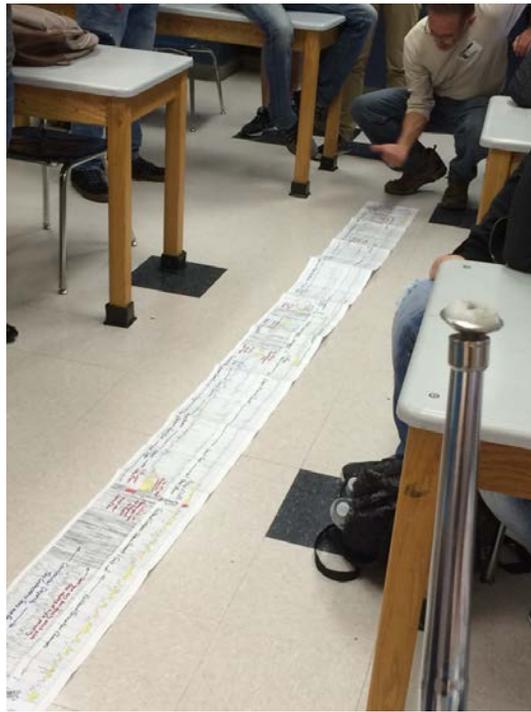


Figure 4. Some of the 3D modeling projects for the three major classifications of plate boundaries.

### Merrion Oil and Gas Company Visit:

Jacob Sharpe, Investment Manager of Merrion Oil and Gas of Farmington, NM visited and presented the importance of Science and Math in the Oil and Gas Industry in the Four Corners. He modeled a mathematical problem that shows its importance in determining where to drill a well for natural gas resource. A sample problem activity was also modeled to the students to show the importance of understanding the concepts of Algebra, Geometry, Volume and Density in tapping an energy resource where about 45% of Americans are now dependent.



**Figure 5. Top photo Jacob Sharpe from Merrion Oil and Gas unrolls the Spectral Density Dual Spaced Neutron Deep Sensitivity Log. Bottom Photo Mr Sharpe showing the students the importance of knowing Math and Science to determine where to drill a well for natural gas.**

*Halliburton Company Visit:*

Clint Lehar, PSL Service Manager of Halliburton in Farmington presented a slideshow that discuss about the importance of Science (particularly Chemistry), Math (Algebra, Trigonometry & Geometry) and knowledge in computers and engineering in Hydraulic Fracturing (Fracking). The Halliburton group also showed a demonstration of combining chemicals used as a fracking fluid and showed how the process can be reversed. Both invited guests also talked about the Math and Science requirements that they have to complete in post secondary education as well as their prior experiences before they worked in Halliburton.



***Figure 6. Clint Lehar of Halliburton Company and one of their Chemical Engineers demonstrated the combination of 'proprietary chemicals' they use for hydraulic fracturing discussing the importance of understanding Chemistry, Physics and Mathematics to their jobs and to the industry.***

*Navajo Nation Environmental Protection Agency Visit:*

Natural Resource Officer Fred Johnson from the Navajo Nation Environmental Protection Agency in Fort Defiance, AZ visited the school to discuss and model weathering, erosion and best practices to prevent soil erosion in the Navajo Nation.

Mr. Johnson also showed a model of a healthy and an unhealthy watershed in the Navajo Nation due to negligent practices that leads to faster soil erosion which has been recently common in the Navajo tribal lands. He also talked about his career, the importance of Math and Science in his job and why these core classes are helping him educated people in the reservation to do their part in soil conservation.



***Figure 7. Navajo Nation Environmental Protection Agency Natural Resource Officer Fred Johnson shows a model of a typical landscape in the Navajo Indian reservation due to negligent practices such as overgrazing of livestock. Using these models he also showed erosion and what replanting, giving time plants to regenerate and planning where to graze livestock reduces soil erosion and maintaining healthy topsoil.***

*Geology Trip:*

Only (16) students with parental consents joined the trip as a culminating activity for the semester. Students went to Berg Park in Farmington; Hogback in Water flow to see the monocline structure from its East and West side and Shiprock from its North east face (about 20 miles west of Farmington) then traveled to the Area 3 Facility of Navajo Coal Mine south of Fruitland. Detailed lesson plan is Appendix 4.



**Figure 8. Left photo: Students meet Greg Bigman from the office of the President of the Navajo Nation explaining the cultural importance of Tse' Bit' ai' (Shiprock) to the Dine people. Right photo: Students watch the Hazard Safety Training at Area 3 Facility of the Navajo Mine.**

The Geological structure Shiprock also know as *Tse' Bit' ai'* was reviewed to the students from its North Eastern view on our 3<sup>rd</sup> stop as well as other structures similar to it within the area which is part of the Navajo Volcanic Field such as Agathla peak – about 120 km west of Shiprock across the Arizona border and Table Mesa (a.k.a Snoopy rock) along Highway 491. These discussions are part of the ethnogeology component of the lesson since the *Diné (Navajo people)* has a deep connection with all landforms within their

homeland on the Colorado Plateau as described on their stories and histories (Semken, 2003).



**Figure 9. Left Photo: Students were toured into a coal strip area. Right Photo: Joshua Kantor, BHP Superintendent for Drill and Blast shows how the dragline works in the coal mine, how they operate it, the costs and skills that they are looking for from applicants to operate such machineries.**

With the help of Dan Ware, Manager of Corporate Affairs at BHP billiton, the students met various Geoscientists that are working in the Navajo Coal mine. Through a series of short but comprehensive slide show presentations, the Petroleum Engineer, Environmental Chemist, Chemical Engineer, Geologist, Hydrologist and other employees shared their jobs, experiences and importance of STEM in making sure that they are doing their job correctly. These presentations were held in the conference room of Area 3 Facility of the Navajo Coal Mine before the students were toured in the mining area.

Students were accompanied by Dan Ware, Joshua Kantor and another BHP billiton staff during the tour of the mine areas and they explained to them the importance of Science, Technology, Engineering and Math (STEM) in this multi billion dollar industry that

not only provides jobs to the Navajo tribe but also sustains energy in the four corners region.

### **Program Evaluation and Assessment:**

The effectiveness of the program in increasing the student participants' awareness and interest on Geo – STEM careers was assessed through a pre and post paper/pencil survey (which was approved by the Institutional Research Board of New Mexico Institute of Mining and Technology and with parental consent) comprising of 17 questions (See Appendix 7), collection of their responses about understanding the importance of Math and Science in Geosciences as well as the gathering examples of students' works.

### ***Questionnaires and Responses:***

The pre survey was given two weeks before the planned first date of program implementation so that the students as well as their parents will have enough time to discuss about whether they want to get involved in a study versus gaining knowledge and understanding of Geoscience. All the signed/completed pre – survey forms were returned within three days and only one student out of twenty-eight declined to participate. The pre and post survey questions are identical and are program specific which asks the participants to respond to series of questions pertaining to Science, Technology, Engineering, Math; Geoscience; interest in going to college after high school or interest in pursuing rewarding careers in Geology.

A five – point Lickert scale was used to solicit their responses in 13 questions for both pre and post surveys: One question is for Proficiency; two questions for familiarity of STEM and any Geo - STEM – related programs; four questions for importance of STEM, Geo – STEM programs and Geo – STEM program implementation in schools; while six questions are for agreement regarding STEM and Geo – STEM programs. The rest are specific Yes/No and options – type questions.

*Table III. Shows the pre/post survey questions that were given out prior to and after the implementation of the Geo – STEM Career Awareness Program to see if the knowledge and interest in Geoscience improved or increased.*

Questions	Responses
1. Do you know what STEM stands for?	- Yes - No
2. STEM stands for Science, Technology, Engineering and Math. STEM development is a national concern that involves schools, corporations, and the government. Job creation, technological advancement and education reform are three of its top priorities. Which of the top three priorities is most important to you?	- Technological Advancement - Education Reform - Job Creation
3. How familiar are you with STEM?	- Very familiar - Comfortably Familiar - Familiar - Vaguely Familiar - Never Heard of it
4. How is STEM development to you?	- Critical - Very important - Important - Somewhat important - Not important
5. How important is STEM development for the country?	- Critical - Very important - Important - Somewhat important - Not important
6. Does your school offers a STEM related	- Yes

class or classes?	- No
7. Where do you go for STEM related news and information?	- I don't read any information about STEM - Internet - Newspaper - TV/Radio
8. Which of the following would be classified as a STEM related career?	- Teacher - Civil Engineer - Fashion Designer - Lawyer
9. How proficient are you with STEM related technologies?	- Somewhat proficient - Expert Proficient - Not Proficient - Very Proficient - Not Proficient
10. How familiar are you with STEM career fields?	- I've never heard of STEM career fields - I'm not familiar with the STEM career fields - I'm somewhat familiar with the STEM career field - I'm very familiar with STEM career fields
11. What do you think about S, T, E, M as a subject? Please check <b>one</b> box only. a. STEM is an easy subject b. Engineering is enjoyable c. Engineering is important to adult life d. I am good in engineering e. You need Engineering to get a good job f. I know about engineering jobs	- Strongly agree - Disagree - Don't know - Agree - Strongly Agree
12. Have you been involved in any of the following school activities? Circle all that apply.	- A school trip where you learn about the importance of Math, Science, Design or Technology to get a better job? - Class/School visit of a government agency that talks about the importance of Science and Math in getting a better chance to get a job or career. - Class/School visit of a private company that talks about
13. Do you believe that skills in STEM will give you a better paying job after college?	- Yes - No
14. Do you think you need Math and Science	- Yes

to become a Geologist?	- No
15. Why	(Students are to write their reasoning to justify their answer to # 14)
16. Is STEM important to become a Geologist?	<ul style="list-style-type: none"> <li>- Yes</li> <li>- No</li> <li>- No idea</li> <li>- I need to understand what STEM is first before I decide</li> </ul>
17. STEM programs should be implemented in all schools	<ul style="list-style-type: none"> <li>- Yes</li> <li>- No</li> <li>- No idea</li> <li>- I need to understand what STEM is first before I decide</li> </ul>

***Limitations:***

As the primary goal of the study is to see if the Geo – STEM Career awareness program was effective in increasing knowledge and awareness in Geoscience careers, gauging the impact of the classroom activities to the participant students was limited by the following critical factors:

- (1) Time: One semester of Geology – approximately 18 weeks, is insufficient to conduct and produce a more comprehensive longitudinal measure of the effectiveness of the Geo – STEM activities.
- (2) Student interests: Not all students who participated in the study are interested in pursuing a geoscience career to begin with.
- (3) Student’s access to certain websites is filtered – Farmington Municipal Schools leverages the Educational Technology Act [6-15A-1 NMSA 1978] of the New Mexico constitution, which allows school districts to enter into lease purchase agreements for educational technology. This is how 99% of the technology in the school district

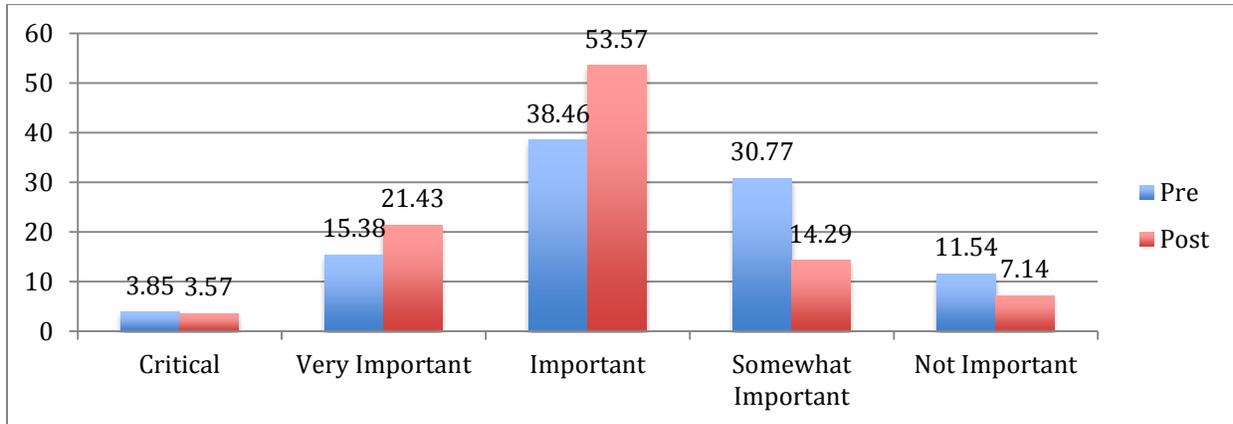
is funded (networking equipment, phone equipment, network services, hardware, software, subscriptions, etc.) thereby has been providing a 1:1 MacBook Air to all of their students that is upgraded on a four-year cycle. Funds are also used to make sure that students will only access educational online resources however as FMS – Executive Director of Technology Charles Thacker put it, “*the Educational Filter System is not 100%*” so some sites that are not allowed to be accessed by students are unintentionally accessed and vice versa. Educational websites such as NetLogo and StarLogo which can be used for programming and understanding the importance of Computer Science in Geoscience is therefore not accessible to the students.

### ***Analysis of Survey Results***

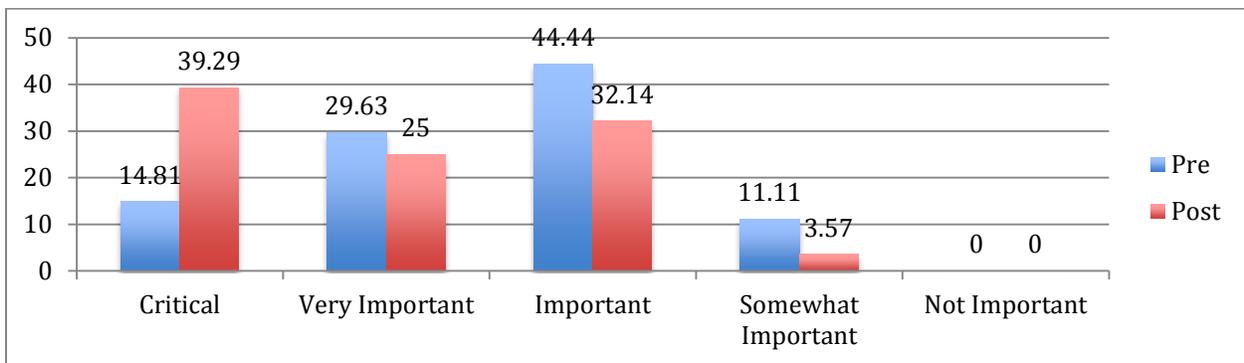
The pre and post survey questions were implemented 3 months apart comprising of 16 questions where number 11 has six sub questions printed on a 3 – pages survey packet. Data were entered on Survey Monkey Inc.<sup>TM</sup> so that responses are easier to assess and analyze then were exported into an Excel data sheet.

Figure 2 shows significant changes in attitude, knowledge and awareness about the importance of implementing a Geo – STEM Career awareness program in the regular Geology class. This suggest that the Geo – STEM Career awareness program was effective in increasing students awareness and knowledge about Geoscience and its careers:

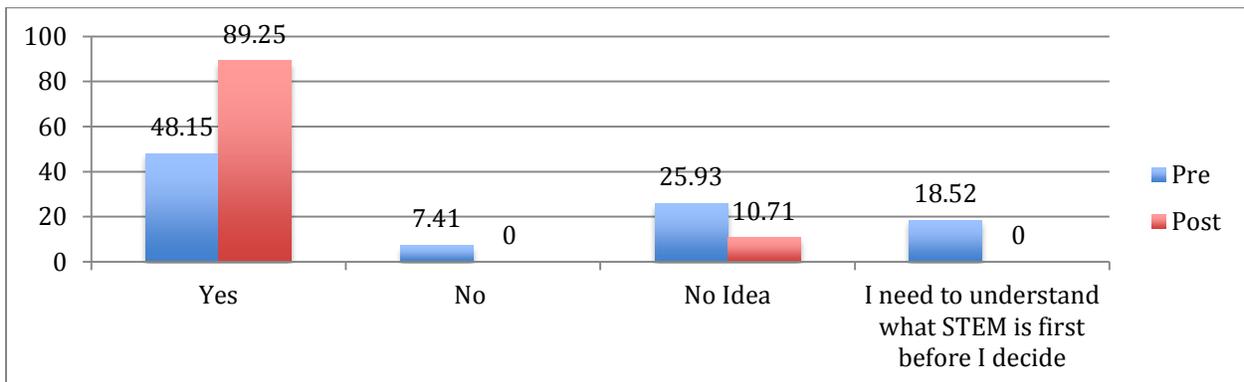
**A. Changes in Knowledge about the importance of STEM to the student**



**B. Changes in Knowledge on the importance of STEM development for the country**



**C. Should STEM be implemented on all schools?**



**Figure 10. Sample results of three pre and post program surveys that show the changes in behavior of student participants about the importance of Geo-STEM programs.**

***Responses to Pre and post program survey question # 14 - 15:***

Feedback from the implemented Geo – STEM Career awareness program was overall positive and 92.8% of the participants responded the post program survey question 11: *“Do you think you need Math and Science to become a Geologist? Why?”* compared to only 66.66% from the pre program survey. Listed below are a few of the responses from the # 14 - 15 question:

S1: *“You need to know them because Math is used to determine hight of volcanos and Science is used to help determine the minerals in the rock”*

S2: *“You need Math for finding out the depth of mountains and such. You need Science to figure out what minerals are in rocks”*

S3: *“You need Math to understand data and Science to figure out what that data means”*

S4: *“Math is very important because volume needs to be known for some jobs like for fracking.”*

S5: *“Yes we use Math all the time like in graphing data and telling what the data means after we graph data. Science help us explain what the data means.”*

S6: *“Because Math enable us to understand data better while Science helps us explain the principles behind those data.”*

Irrespective of whether the responses were a complete and accurate description of the importance of Geo – STEM and the awareness of Geoscience careers, the average of 10.55 words per response of the participants with the Geo – STEM program exposure was significantly greater than the average response of 8 words by those students without prior exposure.

Table IV. Attitudinal data of the participants of the Geo – STEM Career awareness program showing percent number of students answering various sub questions under # 11 about their attitude on STEM and Geoscience:

Statement	Strongly Disagree		Disagree		Don't know		Agree		Strongly Agree	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Q1. STEM is an easy subject	3.7	0	18.52	35.71	66.67	17.86	11.11	42.86	0	3.57
Q2. Engineering is enjoyable	3.7	3.57	11.11	7.14	51.85	25	25.93	64.29	7.41	0
Q3. Engineering is important to adult life	0	3.57	7.41	0	33.33	25	44.44	53.57	14.81	17.86
Q4. I am good in Engineering	7.41	3.57	14.81	32.14	66.67	46.43	7.41	17.86	3.7	0
Q5. You need Engineering to get a good job	7.41	7.14	29.63	28.57	29.63	28.57	18.52	25	14.81	10.71
Q6. I know about Engineering jobs	3.7	0	3.7	0	37.04	7.14	55.56	64.29	0	28.57

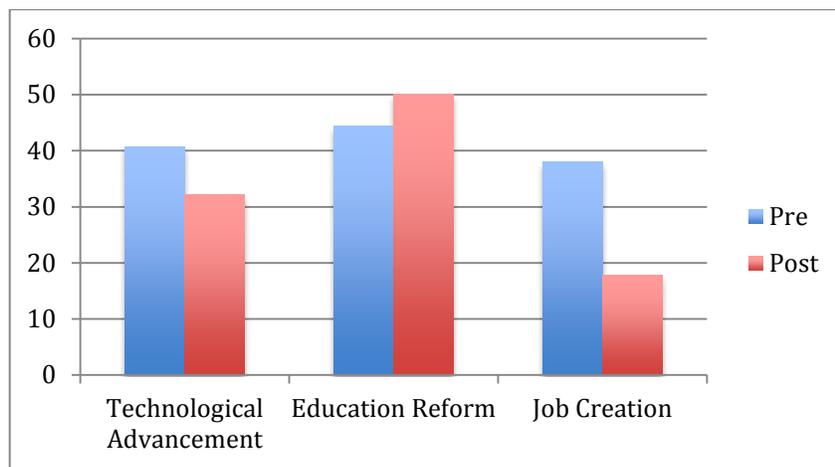
## **Discussion and Conclusion:**

Typical Science classroom scenario where the teacher discuss according to the state standards and EOC blueprint, students listen and take notes, then assess the students at the end of the unit are too objective and understanding the importance of STEM in Geoscience and/or careers may be lacking or is limited.

The Geo – STEM Career Awareness program that was implemented can be seen as a content integration model of STEM education, because it involves ideas, career awareness and knowledge as well as exposure to the real world and competencies from all STEM disciplines such as constructing of an artifact or models (Engineering), collection and analysis of data as well as the application of Mathematics to the oil and gas industry (Mathematics), understanding the Scientific principles (Science) and use of Computer Technology to further understand mapping, GIS and similar tools for Geology (Technology).

After engaging the students to the Geo – STEM Career Awareness Program which was integrated into the Geology class, students shows a higher understanding of what STEM is and it's importance not only to an individual but also to the educational reform and technological advancement in the country (See Figure 11). The successful implementation of this program was based on the need for students to understand that STEM is important in Geology and other Geoscience careers. However, with the discussed limitations as well as availability of professional development for educators is currently the big challenge. Teacher's professional knowledge is a critical issue (Kertil and Gurel, 2015) and a substantial literature talking about teachers lacking of professional knowledge on

mathematical modeling and need for professionally competent teachers for increasing the widespread use of modeling activities in the class room has been widely publicized (e.g. Burkhardt & Pollak, 2006; Kaiser & Maab, 2007; Oliviera & Barbosa, 2009; Niss, Blum & Galbraith, 2007).



**Figure 11. Shows where students believe that STEM Education is critical before and after the implementation of the Geo – STEM Career awareness program.**

In the state of New Mexico, STEM symposium through the Southwest Regional Education Center under the NM Public Education provides NM (and even non – NM) educators some free exposures and resources for STEM Education every end of the school year. The Master of Science for Teacher program at New Mexico Tech in Socorro NM also provides diversified Geoscience courses under its belt that gives educators free access to very informative, engaging and high quality classes taught by respected Geoscientists from their respective fields. NM Bureau of Geology likewise provides a very engaging summer professional development program called “*Rockin’ Around New Mexico*” to its educators with a lot of freebies and educational resource take homes. Center for Science and Mathematics Education through University of Utah also provides an annual *Workshop on*

*Math and Science from Navajo and Western Perspectives* that utilizes place – based learning and incorporates diverse students’ knowledge into classroom teaching. These are some of the very few Earth Science/Geoscience – related professional development that are available to New Mexico Educators. Perhaps if we have more available Geo – STEM and application of mathematical modeling – type professional developments for New Mexico Educators, then we may see an increase in Geo – STEM Education related revolution in our New Mexico schools and therefore an increase in students that will pursue post secondary education in Geology or Geoscience.

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# Appendix 1

Guided Research Activities on Careers that Require STEM

## Geoscientist visit at Piedra Vista High School

Guest Geologist: Kate Pickford, Geoscientist

OCD, District III

1000 Rio Brazos Road, Aztec, NM 87410

### Reflection Questions:

1. Cite three challenges that a Geology student will encounter during the course of his/her study in college? These challenges may have been mentioned by Kate or your personal reflection by inferring the experiences and stories that she has shared.
2. Why do you think the knowledge on the use and reading of maps is important in Geology?
3. Why do you think math skills is important in becoming a Geologist?
4. Briefly discuss how Kate talked about how she used maps in her life of work.
5. List all the (good or bad) adventures that Kate has experienced in her career as a Geologist. List as many as you can remember.
6. Do you think Geologist/Geoscientist is a career that you would consider if given the opportunity? Why or why not?
7. List all the lessons that you have learned from Kate's presentation, being it about life, college, after college or to be a Geoscientist. Do you think they will help you along the way in achieving your goals? Why or why not?

## STEM Careers on Geology

Article for today: *Do you want to become a volcanologist?*

Read the article then answer the following questions:

1. How is being a Volcanologist beneficial to anyone? List at least 5. *Be creative! Think of benefits other than what's in the article.*
2. What classes (subjects in Middle School and High School) do you need to be able to become a volcanologist? Explain (in your own opinion) why these classes are important in Volcanology.
3. Use the internet to identify 5 closest colleges or universities to your current location that offers either of the following college courses:
  - (a) Geology
  - (b) Geochemistry
  - (c) Petrology
  - (d) Hydrology
4. Why is continuing your Bachelor's Degree to Doctor of Philosophy (PhD) important?
5. What other opportunities will you be able to experience after obtaining your PhD?
6. What possible challenges will you face if you will pursue a degree in Geology that leads to Volcanology after High School? List at least 5
7. List all the possible job opportunities for a Volcanologist and use the internet to find out about the current minimum salary rate of these job opportunities.
8. *Self Reflection:* Now that you have read and seen a very brief description of the pathway leading to a career in Volcanology, write a short essay stating why or why not will you pursue this career. Consider that you will get a full academic scholarship from your Bachelors Decree to Doctor of Philosophy.

# Appendix 2

Paper Guide for the College of Energy trip at SJC

## Visit to the School of Energy at San Juan College

Date: September 24, 2015

3<sup>rd</sup> Hour – Geology Class

### Activity # 1 – My Mineral

Directions:

1. Go around the mineral museum and choose **one** mineral from the displays.
2. Write the following about it:
  - (a) Where was it found
  - (b) Chemical formula
  - (c) Common Name
  - (d) Describe the color
  - (e) Take a picture
3. When you get back to PVHS, research about it's:
  - (a) Uses & Importance
  - (b) Other parts of the world where it is found
4. Write about the mineral that you have chosen and include all the information that that you have gathered above. Include in your writing the reason why you chose this mineral.
5. Follow the template below for your paper:

### Activity # 2 – Featured Fossil

Directions:

1. Go around the mineral museum and choose **one** fossil from the displays.
2. Write the following about it:
  - (a) What is the name of the fossilized organism?
  - (b) What is it's scientific name (if not available, then you have to research about it when we get back to PVHS)
  - (c) What part of the body of the organism was fossilized?
  - (d) Describe the fossil (it's features, color, significant marks, etc.)
  - (e) Where was it found (if available)
  - (f) Era, Period or million years ago when it existed
  - (g) Take a picture
3. When we get back to PVHS, research about it's:
  - (a) Scientific Name (if not available in the display)
  - (b) Habitat (Where it usually lives)
  - (c) Diet (What does it eat? Is it a carnivore? An herbivore? Omnivore?)

### Activity # 3 – Augmented Reality Sand Box

Introduction: A NM Bureau of Geology Geologist will present to us this technology. Write down all the important information that they will talk about on your notebook.

Information that they may discuss involves its brief history, uses and importance as well as applications in Geology and mapping.

Part A. Depressions.

1. Create 3 depressions (lakes) on the sand box and fill it with water.
2. Create a mesa (or a butte) in between 2 of the three lakes.

Part B. Elevations.

1. Create 2 mountains of different elevations. Create rain. Where does the water go? Create a continuous river in your set – up.
2. Create a mountain with valley on one side. Make it rain. What happens to the valley?

Part C. Guide Questions:

1. List down all the parts of the Augmented Reality Sandbox that is visible to you.
2. What are the uses of Sandbox technology to Geology, specifically to mapping?
3. In designing a program like this, do you think you need to have advanced or basic knowledge in Science and Math? Why?
4. Is this a good 3D model for studying topography? Why or why not?
5. Write a short essay about what you did today. Include in your essay with 300 – 400 words what you have learned from this activity.

Due Dates: September 25, 2015 – send me as an e-mail attachment in PDF format before 5pm or as a print out (colored) on Monday – September 28.

# Appendix 3

3D Model Making Paper Guide & Rubric for Plate Boundaries

## Geology

November 10, 2015 (Tuesday)

Activity: Construction of 3D models of Plate Boundaries

**NMSS: II.III.9 – 12 Benchmark II.** Examine the scientific theories of the origin, structure, energy, and evolution of Earth and its atmosphere, and their interconnections.

3. Describe the internal structure of Earth (e.g., core, mantle, crust) and the structure of Earth's plates.

5. Explain plate tectonic theory and understand the evidence that supports it.

7. Describe convection as the mechanism for moving heat energy from deep within Earth to the surface and discuss how this process results in plate tectonics, including:

- geological manifestations (e.g., earthquakes, volcanoes, mountain building) that occur at plate boundaries

- impact of plate motions on societies and the environment (e.g., earthquakes, volcanoes).

**Next Generation Science Standards Practice:** Developing and Using Model

Objectives: By the end of the period, learners are expected to:

1. Create a 3D model of the three different types of plate boundaries
2. Summarize the characteristics of diverging, converging and transform plate boundaries.

Materials:

Stuff that are available for you in the classroom (Be creative!)

Directions:

1. Create a 3D model of the three different types of plate boundaries.
2. Draw the lines on your construction paper to create a table just like below:
3. Make sure you have wider columns and rows for your '3D Model Representation' so you have enough space to glue or attached your 3D model.
4. Fill up the information for the description and provide 1 example location on your table. Base your answers from the foldables on your notebook!
5. Refer to the rubric below on how you will be graded:

	Excellent (10)	Satisfactory (7 - 9)	Needs Improvement (4 - 6)	Unacceptable (0 - 3)
Details	All the types of plate boundaries and types of convergent boundaries were well described and models were created in	Most plate boundaries and most types of convergent boundaries were summarized and models were created	More details and descriptions are needed for the types of plate boundaries	Details lacking in most types of plate boundaries.  < 3 of the plate boundaries and types of convergent boundaries were not described/modeled

	details			correctly.
Creativity	Materials in the models were uniquely used to create a visual representation of the types of plate boundaries.	Good creative use of the materials were shown in the models.	Models are simple and can easily replicated.	Lacking creativity.
Neatness/Clarity	Writings, descriptions and models are very neat and easy to understand	Some of the writings, descriptions and models are neat and understandable	Most of the writings, descriptions and models are hard to understand	All of the writings, descriptions and models are hard to understand
Appearance	Project stands out from the rest, shows evidence of considerable effort	Project is organized and shows evidence of good effort	Shows some evidence of effort	Tremendously lacking in effort

6. On an extra sheet, answer the following questions below then staple your answers on your finished model:

- (a) What is the main reason why the plates of the Earth's crust move? (Recall our lab last week!)
- (b) Why is the transform plate boundary that created the San Andreas Fault in California one of the most studied plate boundaries in the world?
- (c) Briefly explain the *Pacific Ring of Fire*. Where is it located and why is it popular to Geoscientists?

7. This project is due TODAY – November 10, 2015. Otherwise, 5 points off every one day late!

# Appendix 4

Detailed Lesson Plan for the Geology Trip

## PVHS Geology Trip

Destinations: Berg Park, Farmington; Hogback, Waterflow and Navajo Coal Mine (Area 3 Facility), Lower Fruitland, NM

The purpose of this trip is to:

- (a) Get the Geology class students visit a real mine
- (b) Talk to Geologists and geoscientists about their career, their responsibilities as well as the importance of Math, Science, Technology and Design to their jobs.
- (c) Get a chance to see the tools and devices these Geologists and Geoscientists use in the field.
- (d) Visit and assess a monocline (Hogback Mountain), 20 miles West of Farmington
- (e) View the beauty of the Igneous rock structure Shiprock from it's northeast side
- (f) Understand the cultural significance of Shiprock to the Dine people.

### Activity:

There are 16 students in this trip. Find a partner to work with in writing down notes, discussions, illustrations and asking interview questions.

### Location 1: Berg Park:

Observe: The rocks that you see around you, specially the ones that are near the river beds.

Questions to ponder:

1. What are the typical shapes of rock near the river?
2. How many different types of rocks do you see?
3. What is the most common type of rock do you observe near the river?
4. If you will hike up in a mountain, do you think you will see that same type of rocks with the same shapes? Why or why not?
5. What is Erosion?
6. What is the erosion factor in a river system?

### Location 2: Hogback:

Observe: The Big rock.

(We will park a few distances from the east side of Hogback. Then we will drive to the other side to view the monocline from a different angle)

Questions to Ponder:

1. What is a monocline?
2. Do you see any folds in the mountain?
3. What could have caused the folding in these rocks?
4. What is a 'bed'?
5. Do you observe 'beds' or 'beddings' in this monocline.

Location 3: Shiprock:

Observe: The Rock from it's NE face

Questions to Ponder:

1. What is the shape of the rock from the angle where you stand?
2. What is a diatreme?
3. What is volcanic plug?
4. Do you see any structures like this around?

Location 4: Facility 3 of the bhp company Navajo Mine

Observe: The area: Beddings, Rock types, Facility of the Mine

Task: You and your partner have to choose two questions from the list below. You HAVE to ask a staff (maybe one of the Geoscientists? Engineer?) who will tour us in the mine. You may ask more than two question but you HAVE to ask a minimum of TWO. Make sure you document all their answers and additional information.

1. Do we need to have a Science College degree to work in this type of industry?
2. Do we need to take a lot of Math and Science classes to become a Geologist/Geoscientist?
3. If so, what are the typical Math and Science classes and are they difficult?
4. What is the importance of Math and Science classes in your job?
5. What tools and devices do you use in these types of industry?
6. Do you do a lot of writing in your job? If so, what kind of writing?
7. Do you travel a lot?
8. Do you need to be computer literate for your job?
9. How much is your annual salary (yes, most of them asked this).
10. What skills do most employers in this industry are looking for from applicants before they hire them? Why?

# Appendix 5

Sample Worksheets for the Geo – STEM Program with Guest  
Speakers

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Geology 2015

Geoscience – STEM Program

November 9, 2015

Guest Speaker: George Shape (Merrion Oil and Gas Company, Farmington NM)

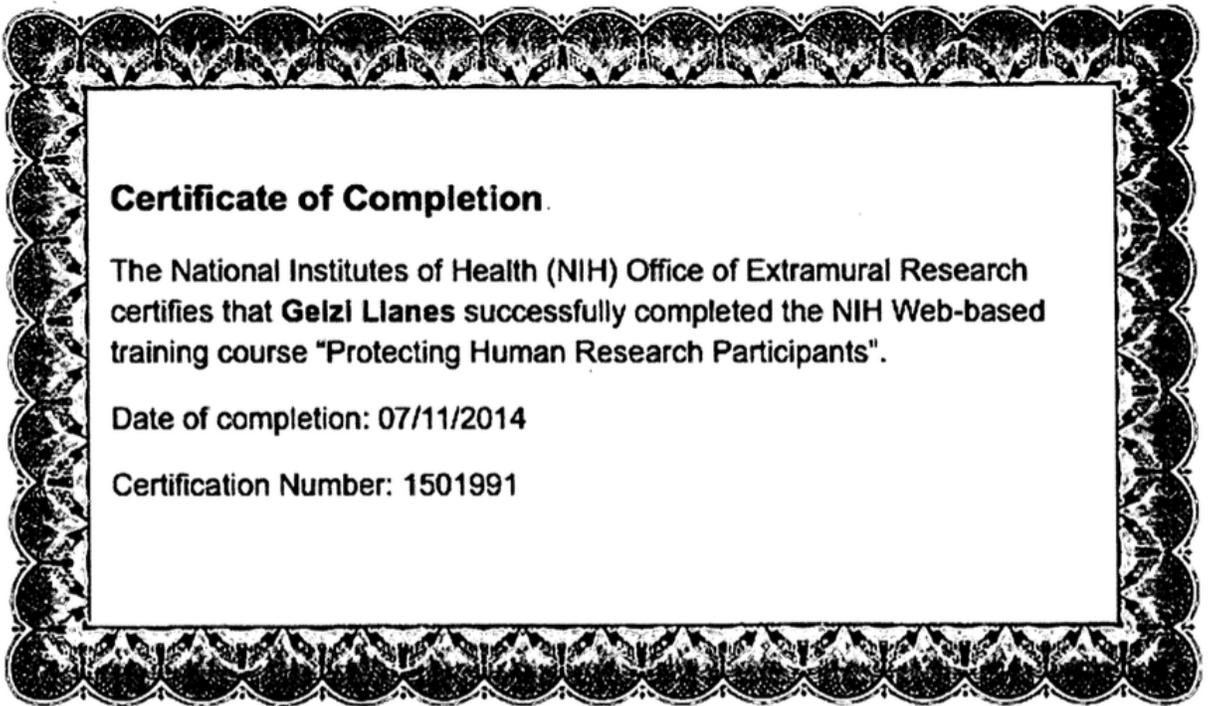
If you didn't passed out last Friday, here's what I want to know from you:

1. Why is knowledge of Math and Science important to Mr Sharpe's job?
2. Give on example concept/topic/idea discussed by Mr Sharpe last Friday where Math, Science and computers are applicable.
3. What is the bottom line of the presentation of Mr. Sharpe? What is he trying to tell you as a High School student?
4. If you will be given an opportunity (full collage scholarship, financial aid, monthly stipends, etc.) will you pursue a career in Geoscience (Geology, Hydrology, Petroleum, Oil and Gas, Engineering)? Why or why not?



# Appendix 6

Certificate of Completion for the NIH Web – based  
training course “Protecting Human Research Participants”



**Certificate of Completion.**

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Gelzi Llanes** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 07/11/2014

Certification Number: 1501991

1. Do you know what STEM stands for? Yes No
2. STEM stands for Science, Technology, Engineering and Math. STEM development is a national concern that involves schools, corporations, and the government. Job creation, technological advancement and education reform are three of its top priorities.  
Which of the top three priorities is most important to you?
  - Technological Advancement
  - Education Reform
  - Job Creation
3. How familiar are you with STEM?
  - Very familiar
  - Comfortably Familiar
  - Familiar
  - Vaguely Familiar
  - Never Heard of it
4. How is STEM development to you?
  - Critical
  - Very important
  - Important
  - Somewhat important
  - Not important
5. How important is STEM development for the country?
  - Critical
  - Very important
  - Important
  - Somewhat important
  - Not important
6. Does your school offers a STEM related class or classes? Yes No
7. Where do you go for STEM related news and information?
8. Which of the following would be classified as a STEM related career?
  - Teacher
  - Civil Engineer
  - Fashion Designer
  - Lawyer
9. How proficient are you with STEM related technologies?
  - Somewhat proficient
  - Expert Proficient
  - Not Proficient
  - Very Proficient
  - Not Proficient
10. How familiar are you with STEM career fields?
  - I've never heard of STM career fields
  - I'm not familiar with the STEM career fields
  - I'm somewhat familiar with the STEM career field
  - I'm very familiar with STEM career fields
11. What do you think about S, T, E, M as a subject? Please tick one box only.

	Strongly Disagree	Disagree	Don't know	Agree	Strongly Agree
STEM is an easy subject					
Engineering is enjoyable					
Engineering is important to adult life					
I am good in engineering					
You need Engineering to get a good job					
I know about engineering jobs					

12. Have you been involved in any of the following school activities?

- A school trip that where you learn about the importance of Math, Science, Design or Technology to get a better job?
- Class/School visit of a government agency that talks about the importance of Science and Math in getting a better chance to get a job or career.
- Class/School visit of a private company that talks about

13. Do you believe that skills in STEM will give you a better paying job after college? Yes or No.