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

Geizi Llanes
Masters of Science in Teaching
New Mexico Institute of Mining and Technology
900311590

What is STEM?

- STEM is an acronym for Science, Technology, Engineering and Mathematics and is a huge umbrella of a vast array of subjects that fall into each of those terms.

What is Geoscience?

- American Geoscience Institute (GSI) defines Geoscience as the study of Earth and its:
  - > Landforms
  - > Processes
  - > Systems
  - > Natural Resources
  - > Impact on People

Why is Geoscience important?

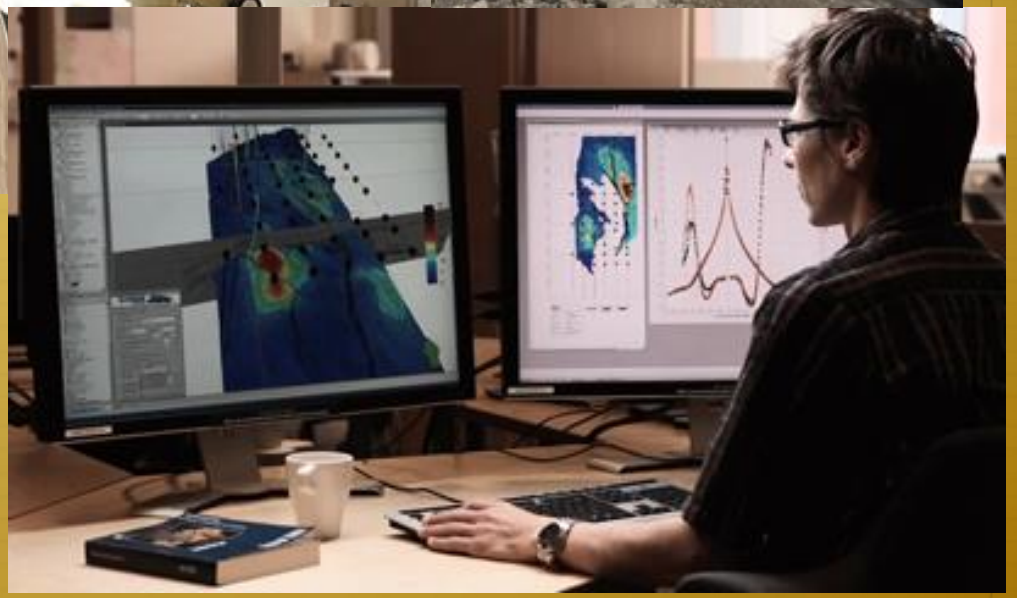
- Geoscience integrates the diverse skills of all STEM fields and applies them directly to real world problems. Geoscience addresses critical issues such as energy, meteorology, water and mineral resources, stewardship of the environment, oceanography, reducing natural hazards for society, planetary science and more!

~ American Geoscience Institute

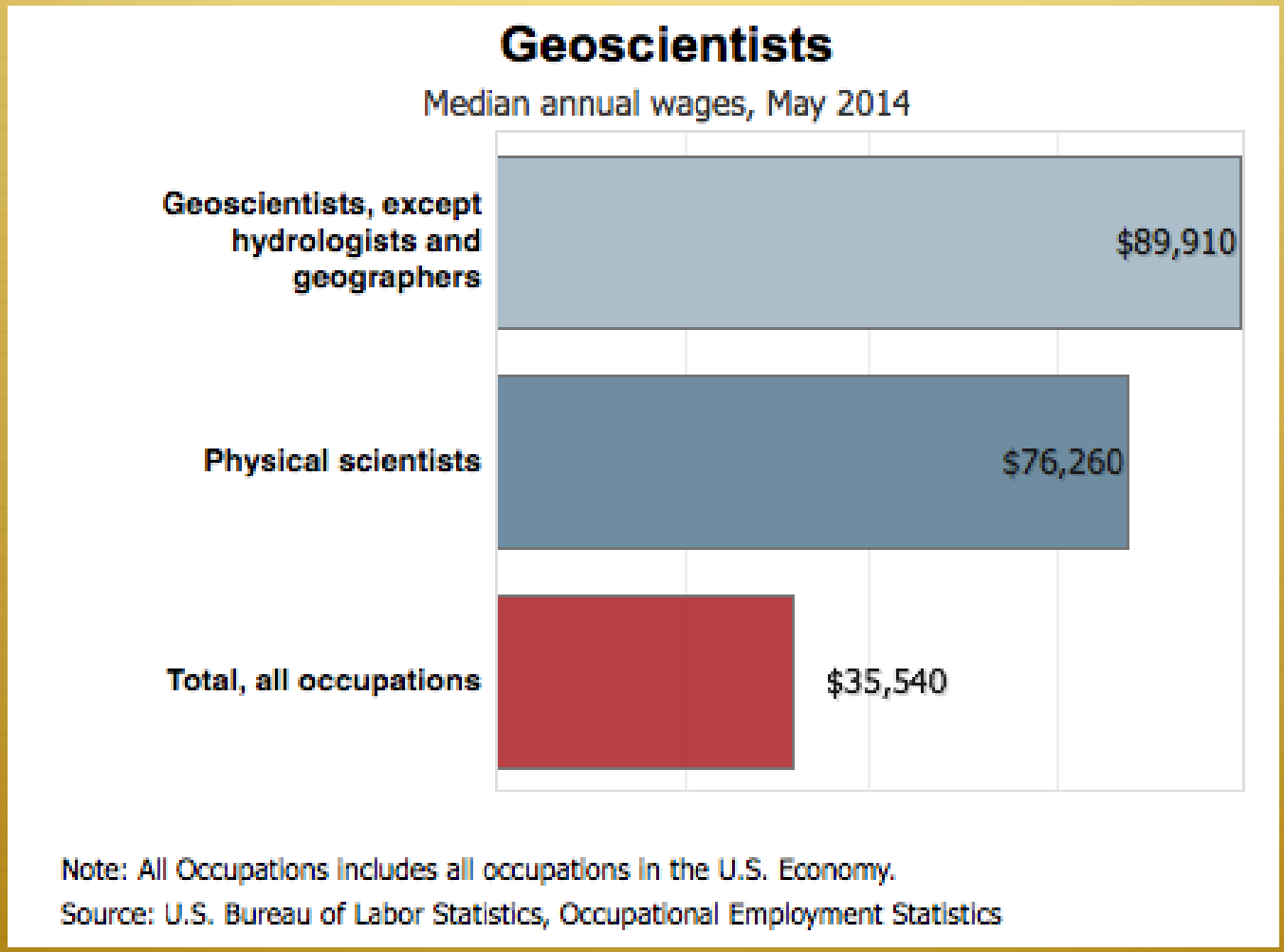
Geoscience Careers

- Engineering Geologists
- Geologists
- Geochemists
- Geophysicists
- Oceanographer
- Paleontologists
- Petroleum Geologists
- Seismologists

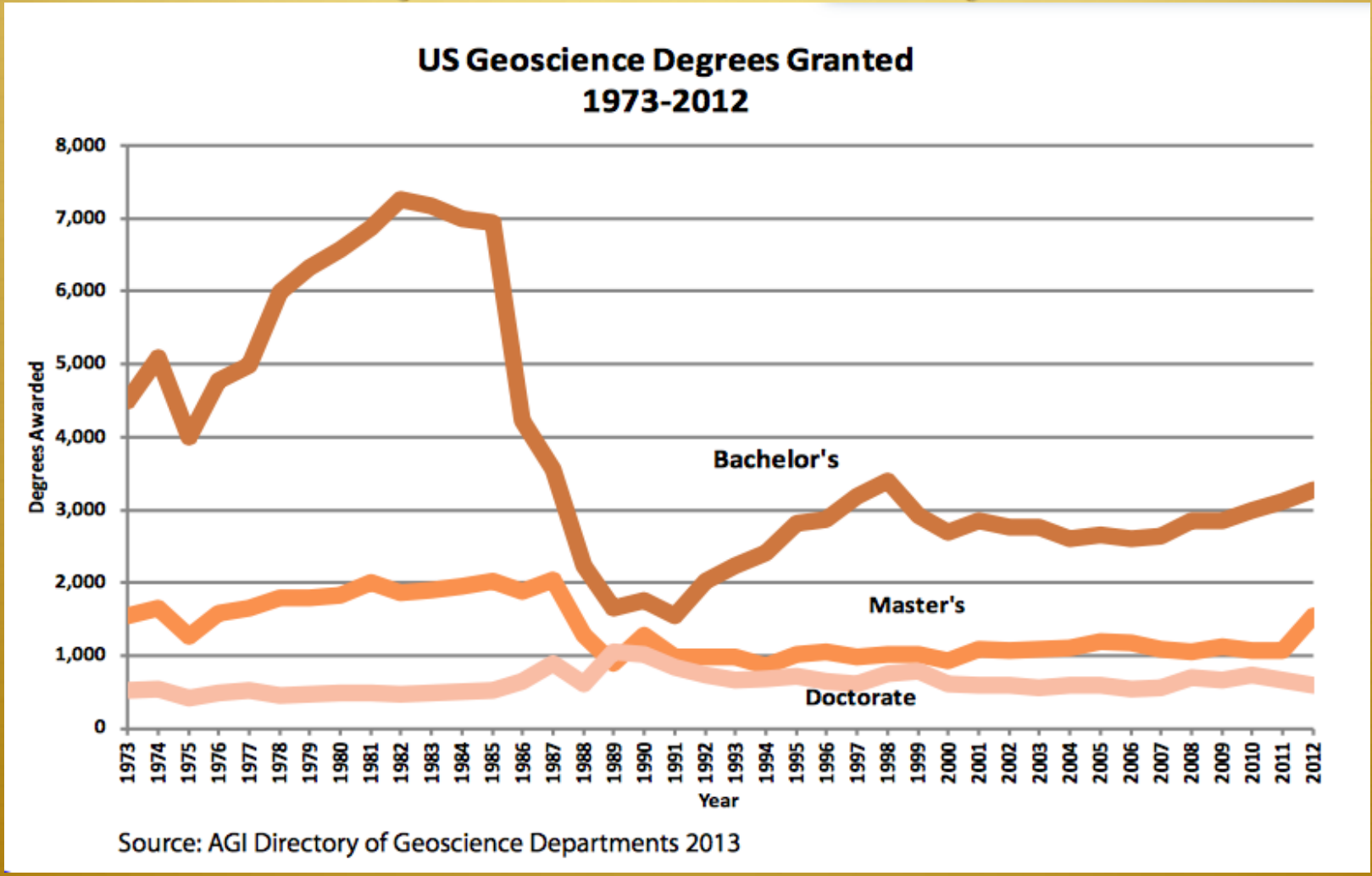
~ Bureau of Labor Statistics, 2005



The Fact…


Geoscientists
Median annual wages, May 2014
Geoscientists, except hydrologists and geographers
$89,910
Physical scientists
$76,260
Total, all occupations
$35,540
Note: All Occupations includes all occupations in the U.S. Economy.
Source: U.S. Bureau of Labor Statistics, Occupational Employment Statistics

The Problem…

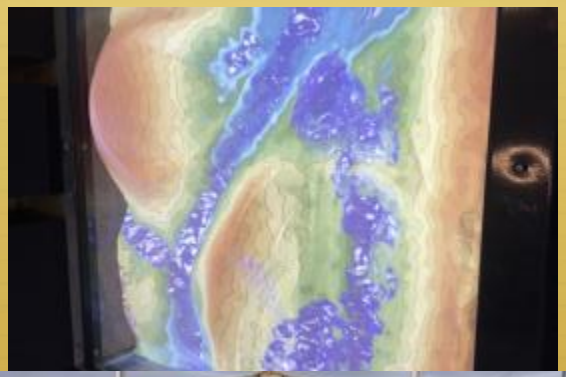

US Geoscience Degrees Granted
1973-2012
Degrees Awarded
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Bachelor's
Master's
Doctorate
1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Year
Source: AGI Directory of Geoscience Departments 2013

The Problem

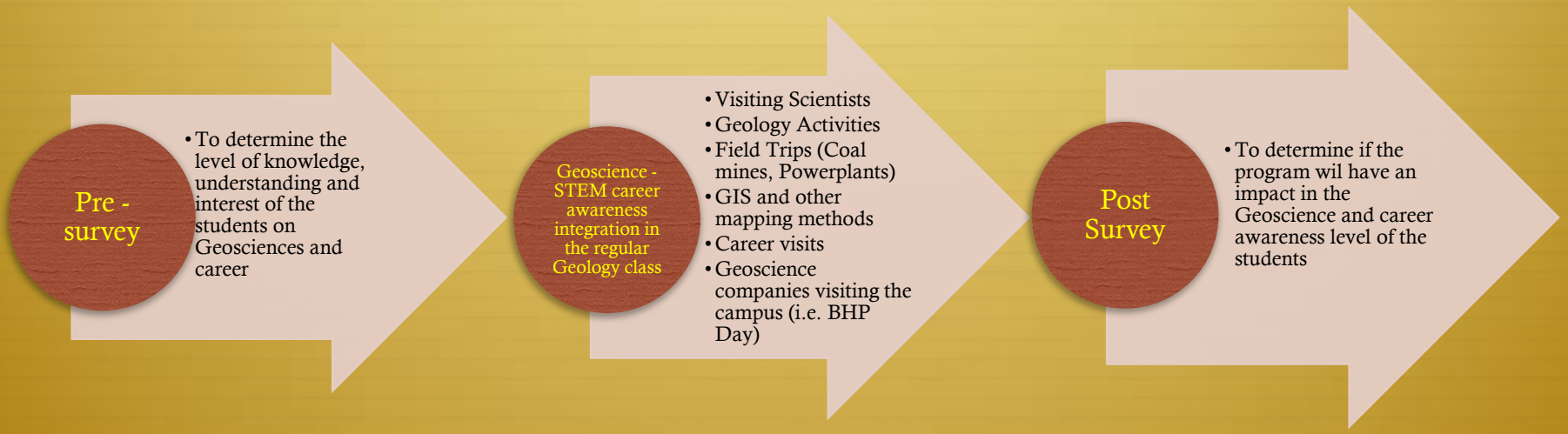
- Although Geoscience degrees conferred in the US sored high from 2011 – 2013 with over 3,200 Bachelor's degree awarded, there is still a significant shortage of these professions.
- Bureau of Labor Statistics indicated on their data from 2000 to 2013 that wages have grown relatively fast in most STEM-oriented occupations, which is a clear indication of a shortage.

Proposed Change

- Integration of a Geo – STEM career awareness program in a regular Geology class.



Suggested Flow of the Program



Purpose

- The program aims to increase students' knowledge and awareness on the Geoscience – Geo – STEM . The program will also introduce the various careers in Geosciences that requires STEM skills.

The Scientific Problem

- Will the integration of a Geo – STEM career awareness program in a regular Geology class increase student awareness on Geoscience careers and knowledge about it?

The Program

- Geo – STEM Career awareness activities are implemented typically on Fridays.

Pre Program Survey

- The following are questions that the students has to answer prior to the implementation of the survey:

1. Do you know what STEM stands for?

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?

   Choose: Technological Advancement

   Education Reform

   Job Creation

3. How familiar are you with STEM?
4. How is STEM development to you?
5. How important is STEM development for the country?
6. Does your school offers a STEM related class or classes?
7. Where do you go for STEM related news and information?
8. Which of the following would be classified as a STEM related career?
9. How proficient are you with STEM related technologies?
10. How familiar are you with STEM career fields?

11. What do you think about S, T, E, M as a subject? Please check **one** 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

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?
14. Do you think you need Math and Science to become a Geologist?
15. Why? (Students are to write their reasoning to justify their answer to # 14)
16. Is STEM important to become a Geologist?

Activities

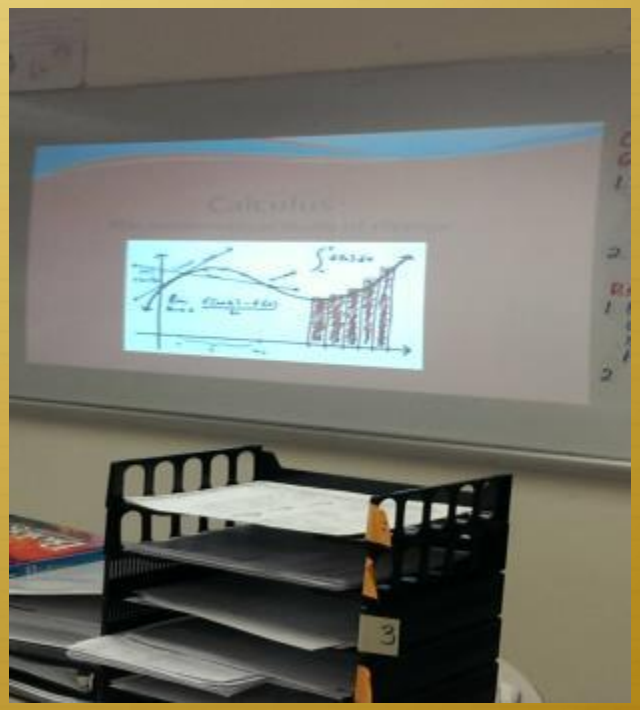
Activity	New Mexico State Standards
Methods of a Scientist	I.I.I.1 – 2, 4 – 5, I.I.II.1 - 2
Classification of Maps	I.I.I.3
Topographic Map Modeling	I.I.I.3 – 4
GPS	I.I.I.3 – 4, I.I.III. 1 - 5
3D Topographic Map	I.I.I.3 – 4, I.I.III. 1 - 5
Convection Current Lab	I.I.I.5, II.I.II.4, II.III.II.6
3D Model Making of Plate Boundaries	I.I.I.5, II.III.II.1 - 7
Mineral Classification Lab	II.III.II.10
School Visit by Merrion Oil and Gas	I.I.I – III, II.III.II. 4 - 7

Activities

Activity	New Mexico State Standards
School Visit by Halliburton	I.I.I – III, II.III.II. 4 – 7, III.III.I.3, II.III.I.19
Igneous Rock Lab and STEM Careers	II.III.II.10, II.III.I.19
School Visit by NNEPA	I.I.I – III, II.III.II. 4 – 7, II.III.II.9, 12, III.III.I.7,9,13, 15,19
Geology Trip	Covers almost all of Earth and Space Science standards and Strand III (Science and Society)

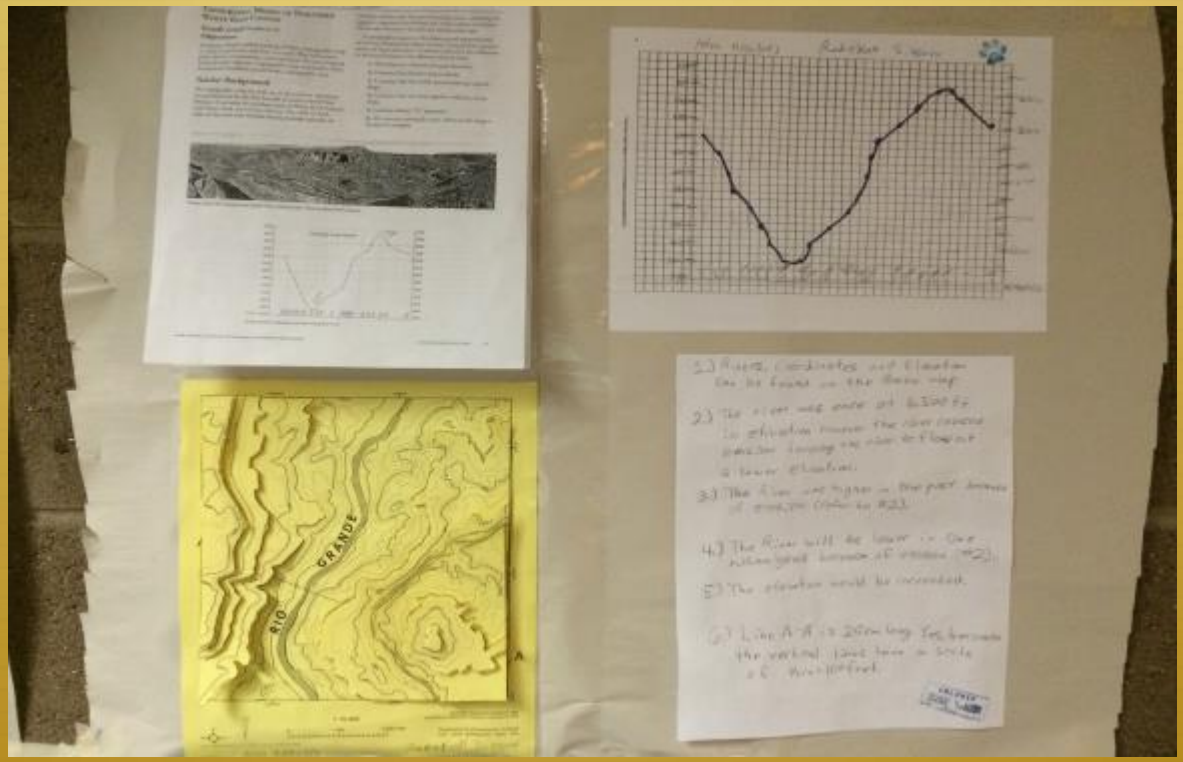
Activities

- 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.



Activities

- Topographic Map Modeling: 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.

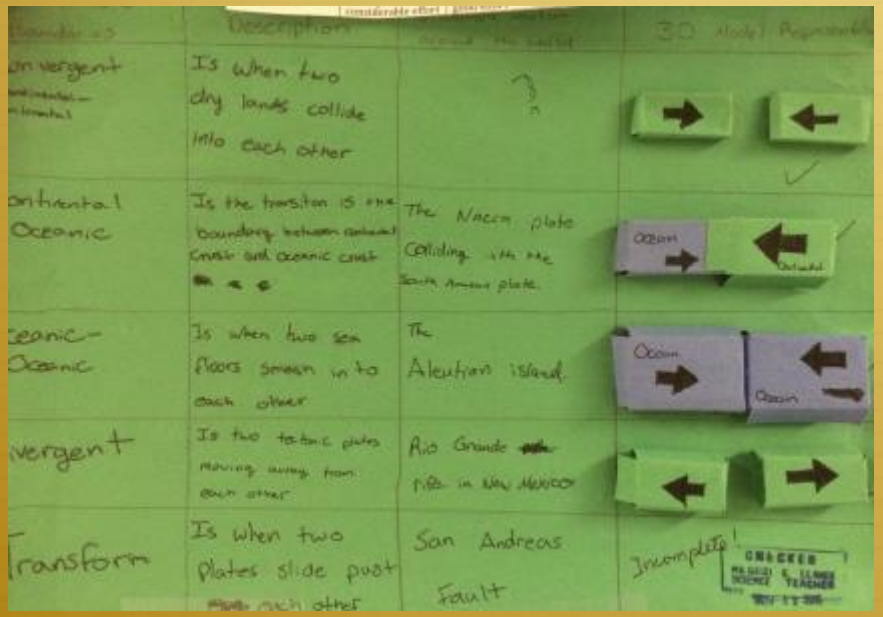


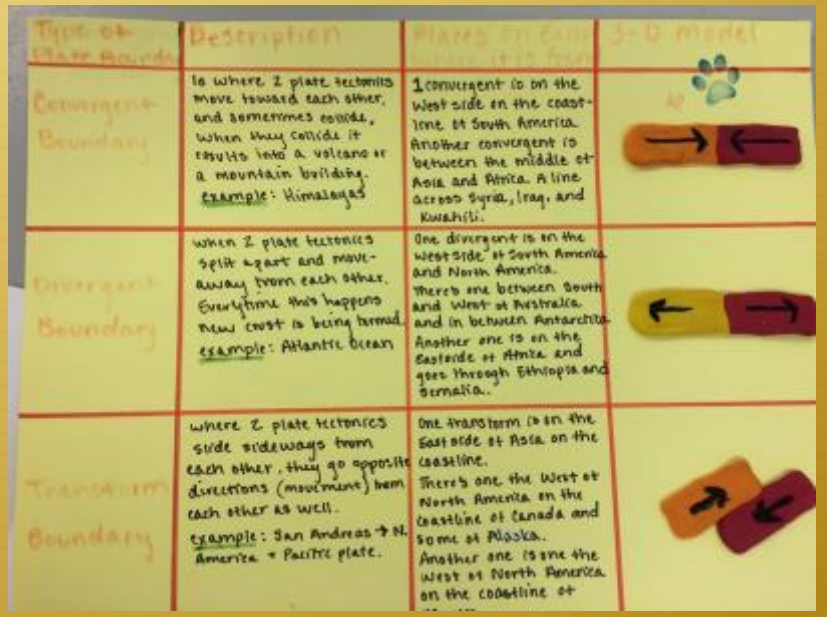
Activities

- Topographic Map Modeling using the Sandbox Augmented Technology: Student created various landscapes such as mountains, valleys, mesas, rivers, depressions and modeled earthquakes and fault lines in the sandbox using their hands and knowledge of Topographic Mapping:

Activities

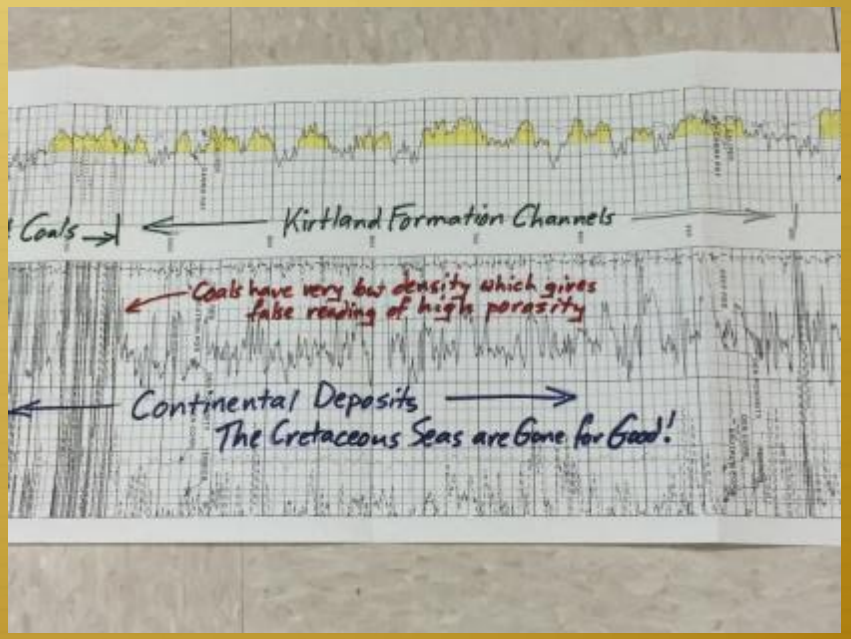
- 3D Plate Boundary Model Making: Students created 3D models for different types of Plate Boundaries:





Activities

- Merrion Oil and Gas Company School Visit: Jacob Sharppe, Investment Manager of Merrion Oil and Gas of Farmington, NM visited PVHS and presented the importance of Science and Math in the Oil and Gas Industry in the Four Corners



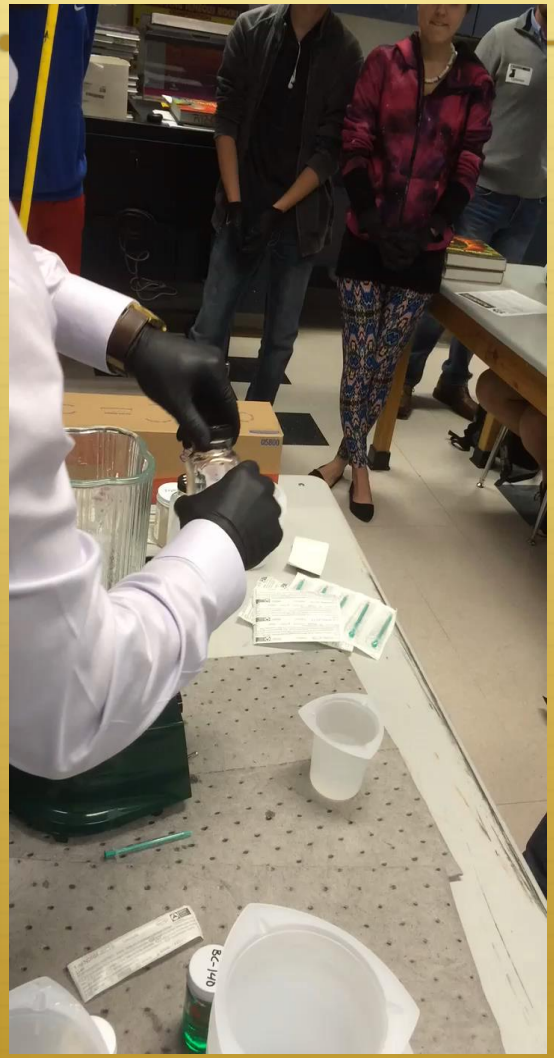
Activities

- Halliburton Company School Visit: 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.

Activities

Halliburton Company School Visit:

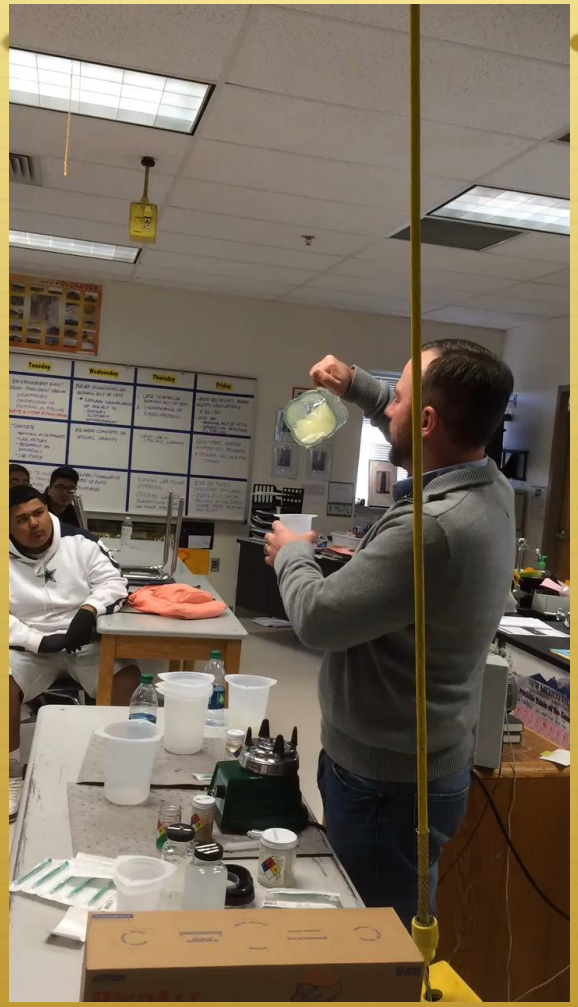
Demonstrate the combination of simple substances to create a fluid the company uses for Hydraulic Fracturing (Fracking)



Activities

Halliburton Company School Visit:

Clint Lehar of Halliburton shows the students the use and importance of Chemistry in the Hydraulic Fracturing (Fracking) industry.

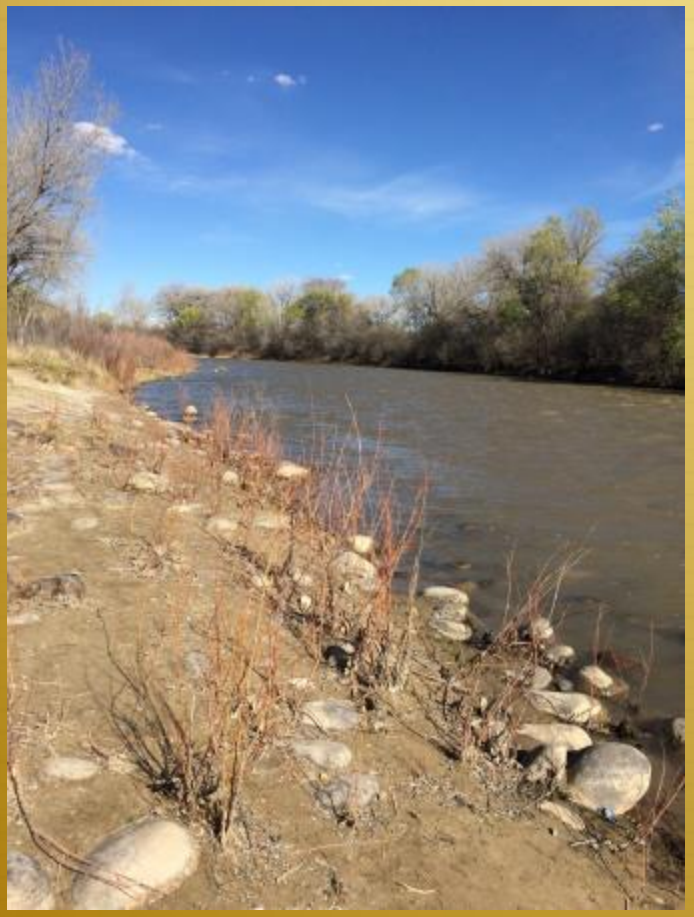


Activities

- Navajo Nation EPA School Visit: Fred Johnson visited the school to discuss and model weathering, erosion and best practices to prevent soil erosion in the Navajo N

Activities

- Geology Trip: Students travelled to Berg Park, Hog Back Monocline and Navajo Coal Mine:



Activities

- Geology Trip: Students travelled to Berg Park, Hog Back Monocline and Navajo Coal Mine:

Left: Discussion of the Geology of Shiprock and it's importance and significance to the Dine people by G. Bigman. Right: Dan Ware introduces the methods they use to move Earth materials prior to mining coal in the Navajo Coal Mine.

Activities

- Geology Trip: Students travelled to Berg Park, Hog Back Monocline and Navajo Coal Mine:

Activities

- Geology Trip: Students travelled to Berg Park, Hog Back Monocline and Navajo Coal Mine:

Students visited the Navajo Coal Mine Area 3 Facility and were toured around the mine showing coal seams and beds.

Activities

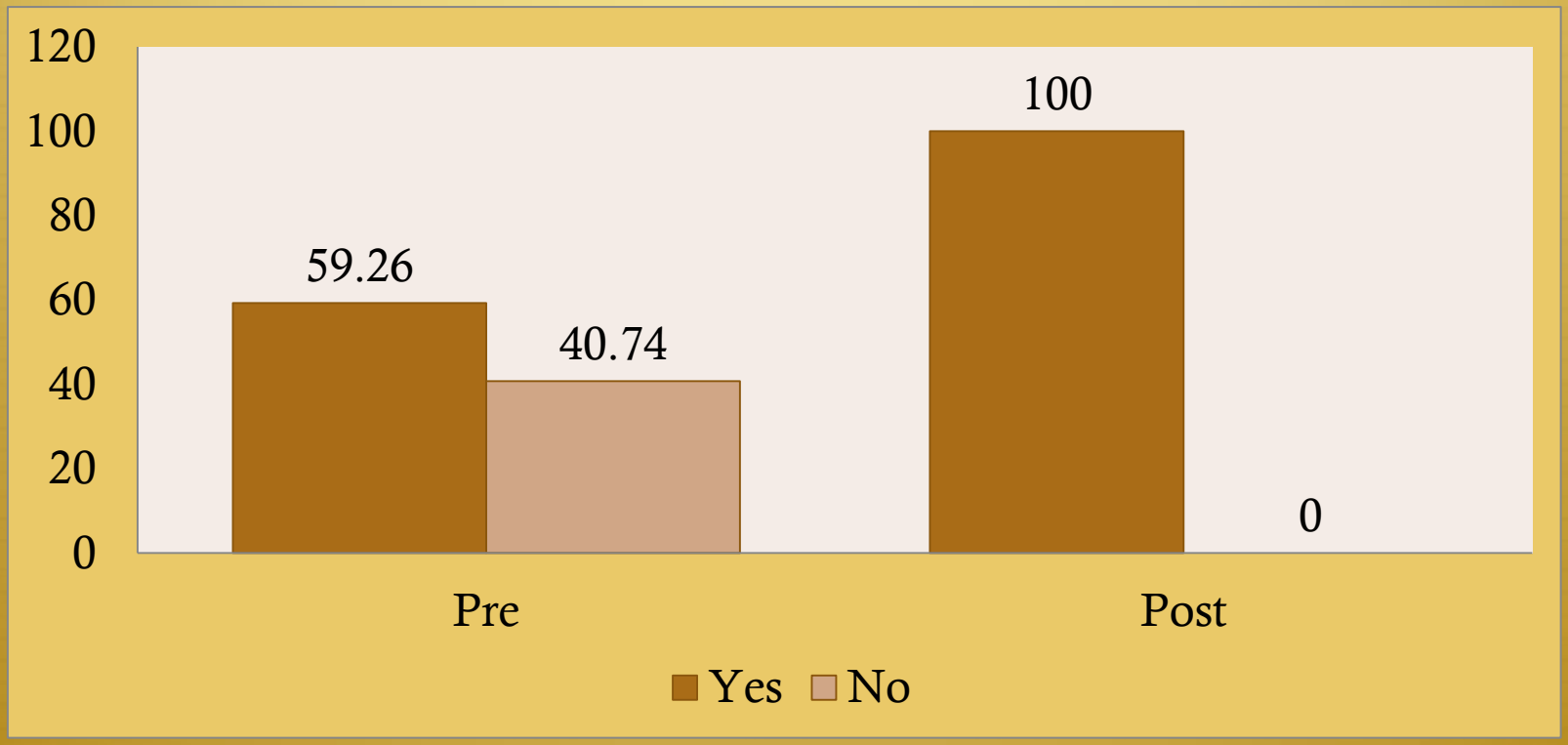
- Geology Trip: Students travelled to Berg Park, Hog Back Monocline and Navajo Coal Mine:

Career opportunities were also discussed after the Safety Hazard training which includes importance of STEM skills in the Oil, Gas and Coal Industry.

The Outcome of the Program

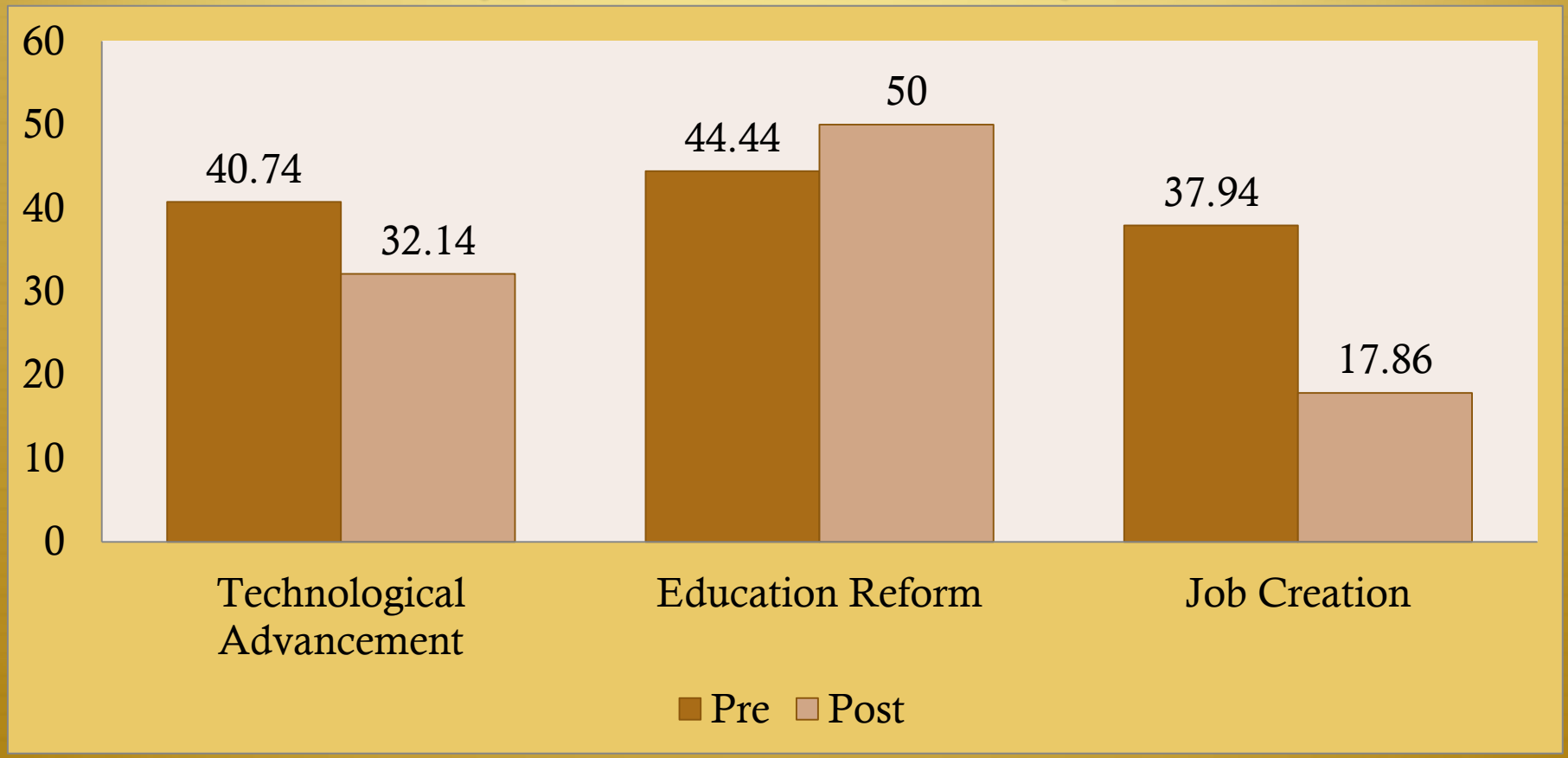
- A post program survey were given out to the student participants before the end of the semester. One student enrolled at the middle of the semester so the number went up from 27 to 28.
- The post program survey questions were identical with the pre – program survey.
- There is a significant increase in the attitude towards the need for Educational Reform and understanding of what STEM is and it's importance in Geoscience careers.

The Outcome of the Program



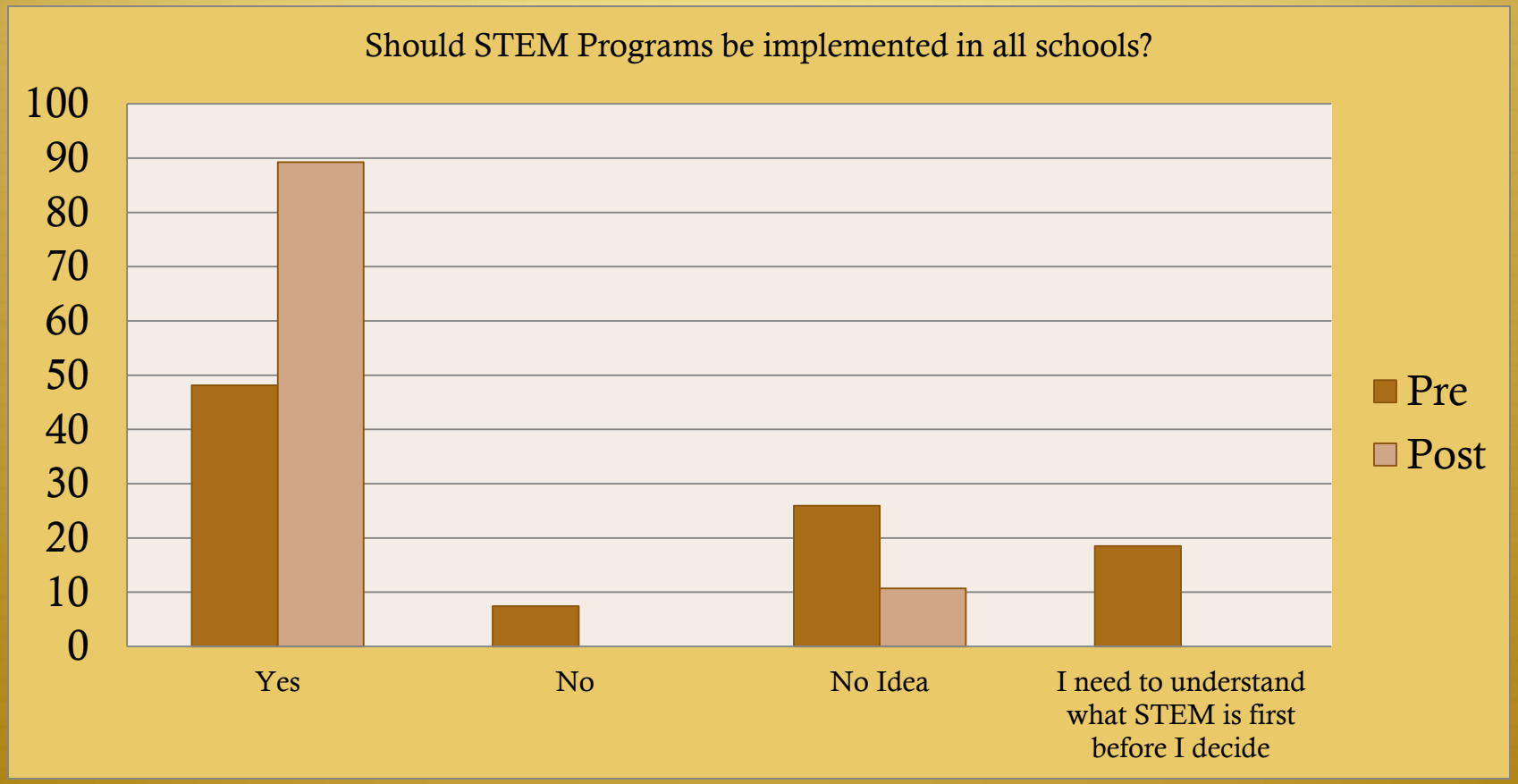
Prior to the implementation of the Geo – STEM Career awareness program, only 59.26% of the participants know what the acronym STEM means both in oral and writing.

The Outcome of the Program



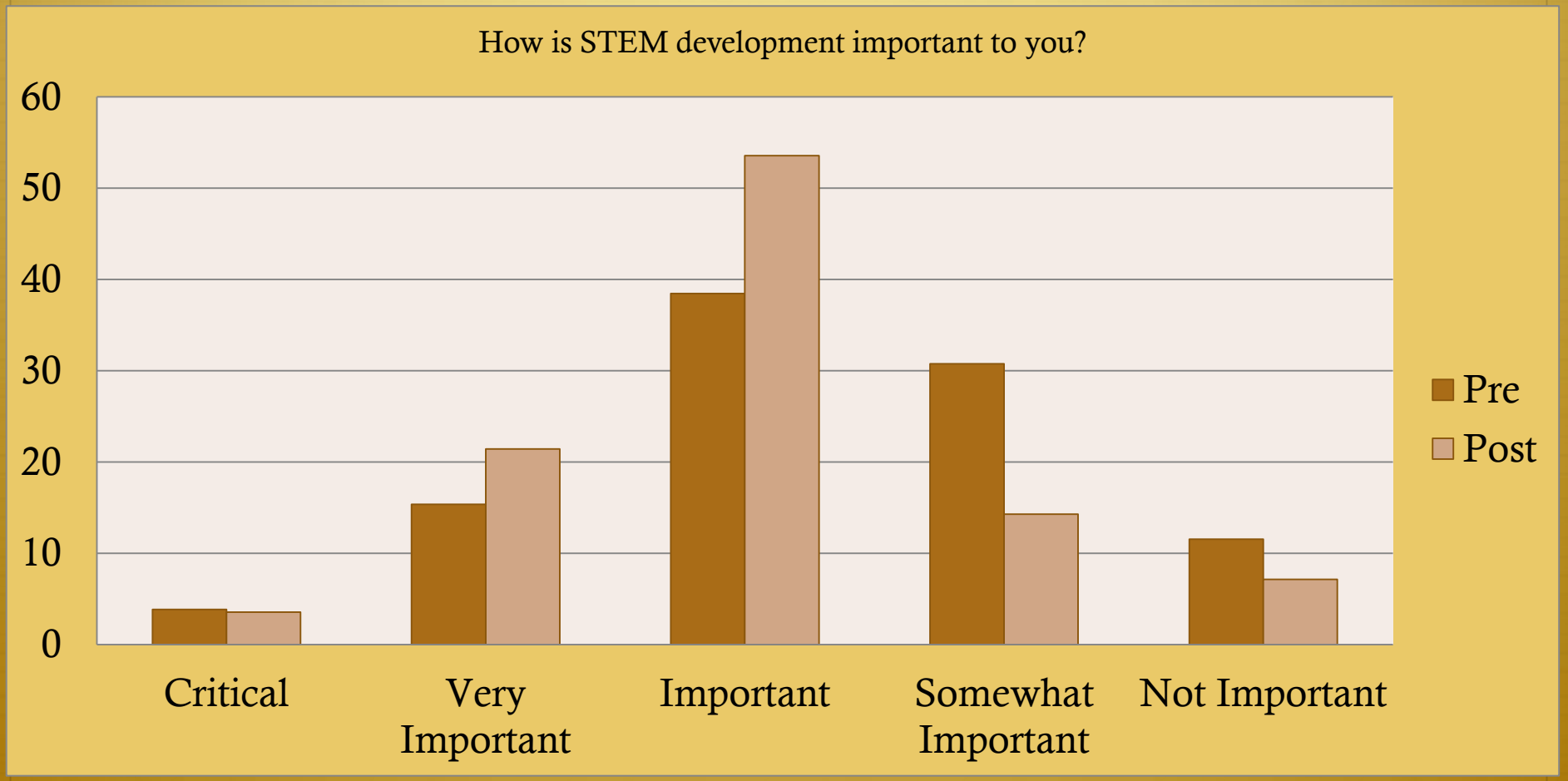
After the implementation of the program, most students (50%) believes that there is an immediate need of Educational Reform where STEM career awareness programs is imperative in all educational settings so students know how to get ready for these careers.

The Outcome of the Program



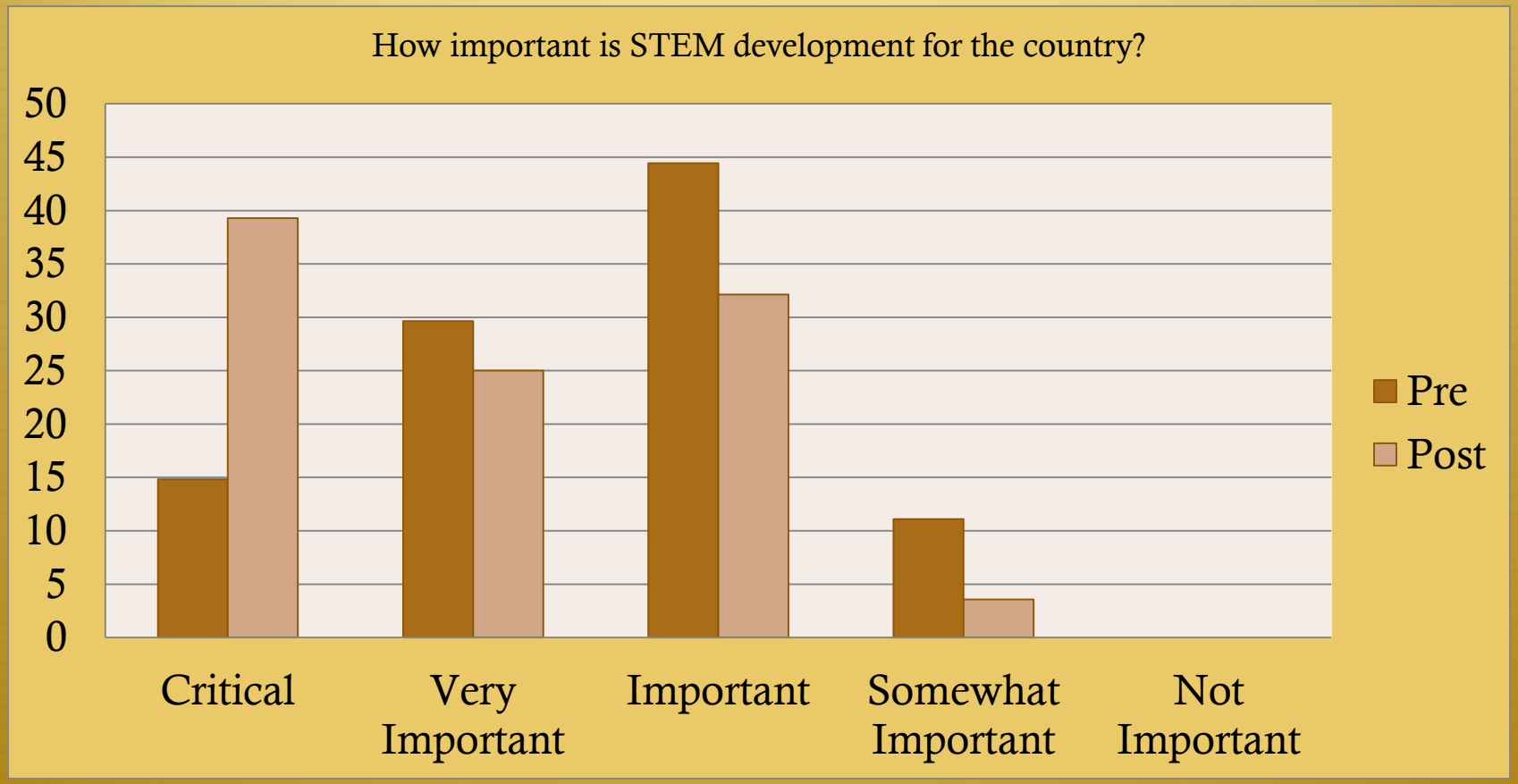
After the implementation of the program, students who believes that STEM should be implemented in all schools increased from 48.15 to 89.25 percent.

The Outcome of the Program



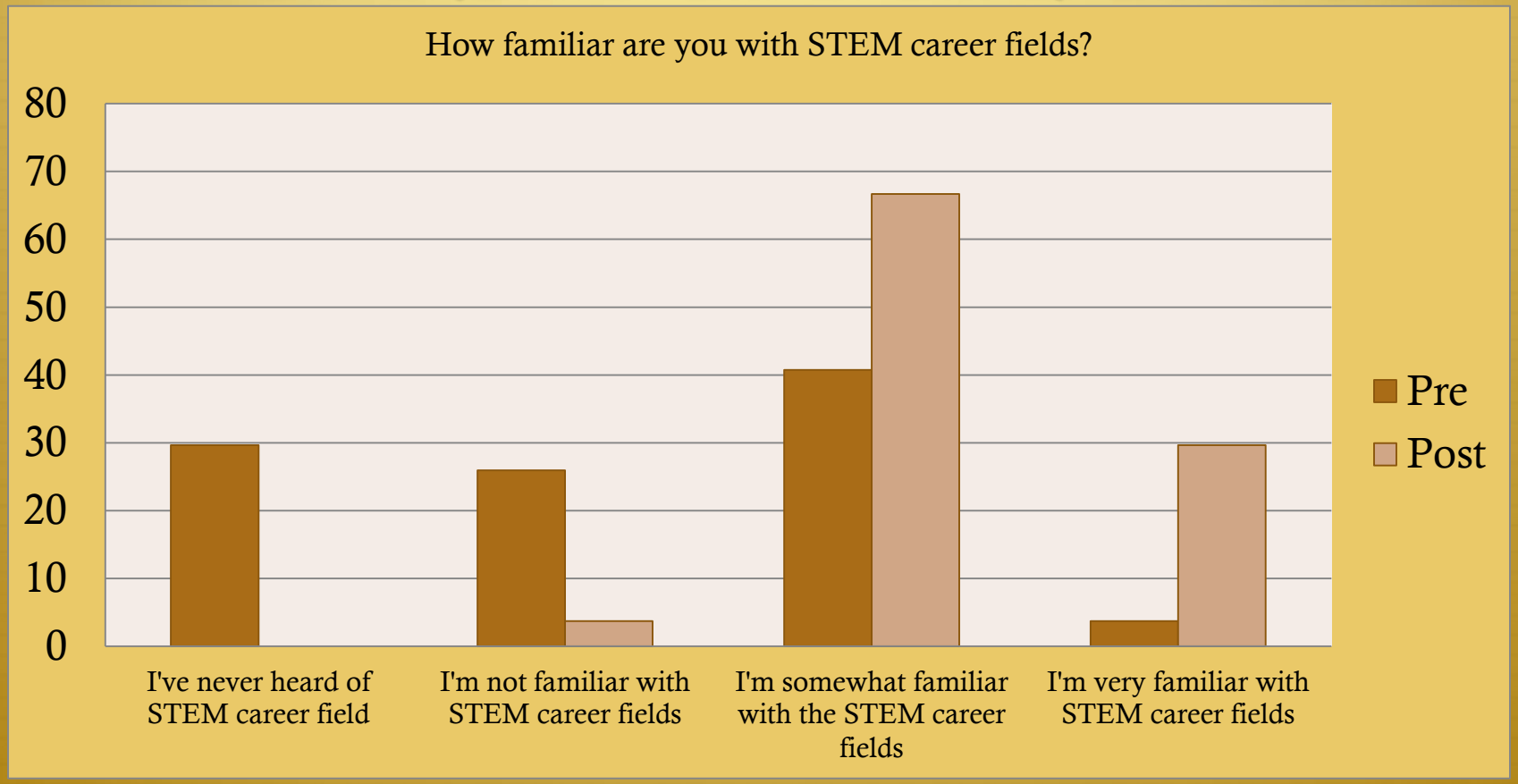
Understanding of STEM also impact student responses on the importance of STEM to the student: 'Critical' from 3.85 down to 3.57, 'Very Important' from 15.38 to 21.43 and 'Important' from 38.46 to '53.57'.

The Outcome of the Program



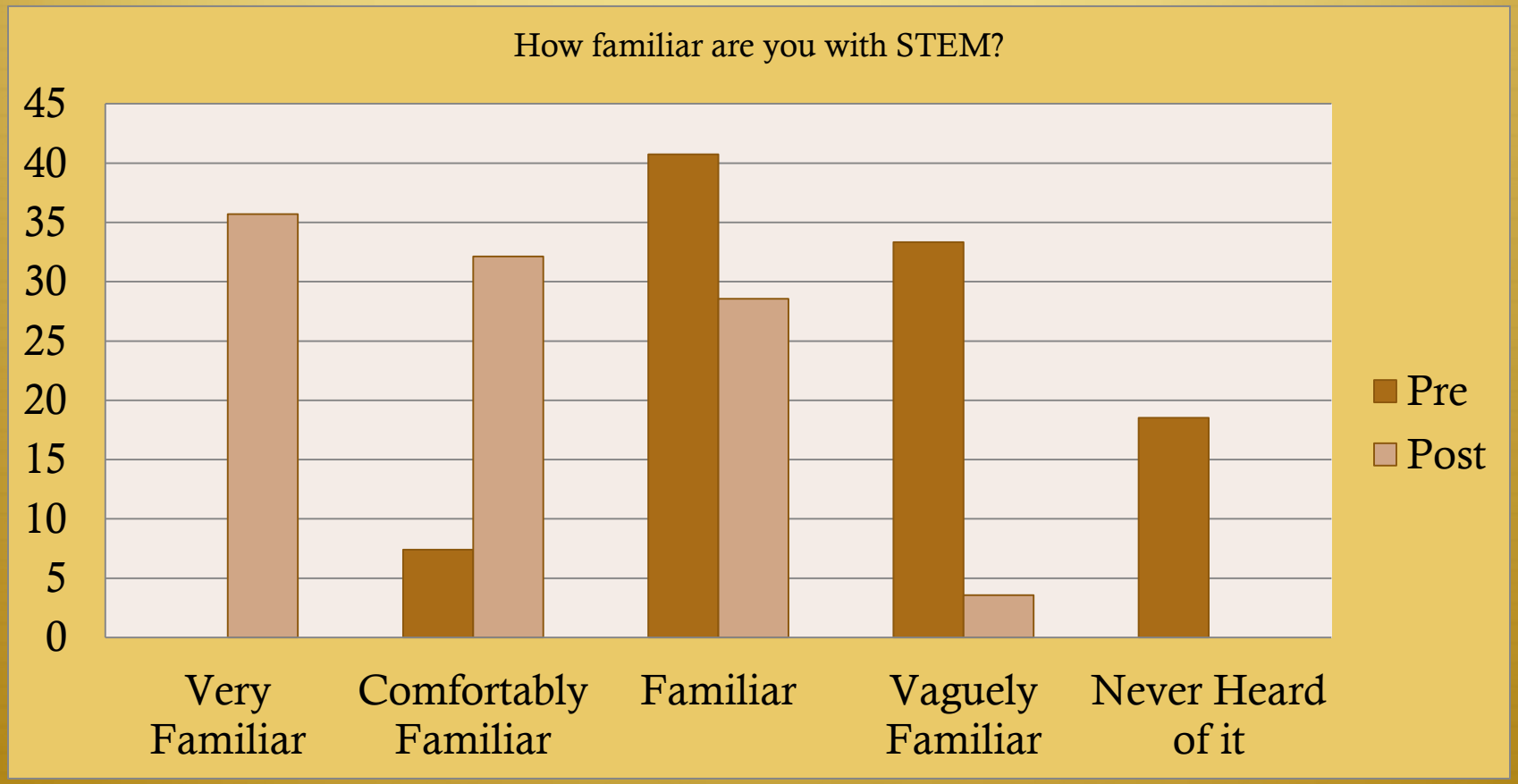
Most students shifted their opinion from 'Important' to 'Critical' about the importance of STEM development to the country after the implementation of the program.

The Outcome of the Program



After the implementation of the program, more students became 'somewhat familiar' (40.74 to 66.67%) with STEM career fields while students who are 'Very Familiar' increased from 3.7 to 29.63%.

The Outcome of the Program



At the end of the Geo – STEM Career awareness program implementation, students were 35.72 % of students became 'Very Familiar' with STEM.

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 14 - 15:

"Do you think you need Math and Science to become a Geologist? Why?"

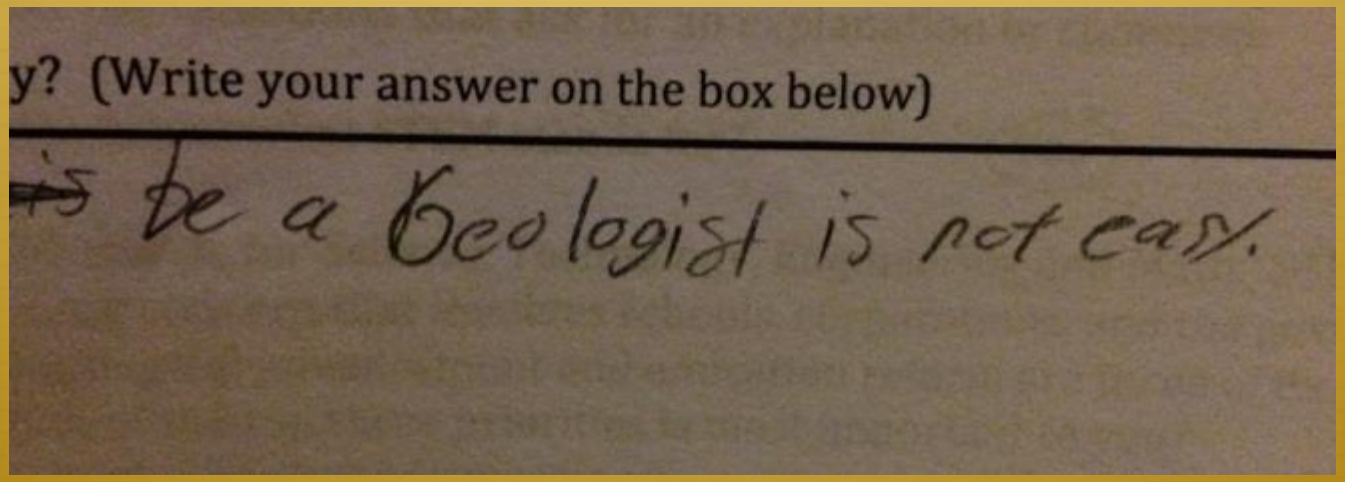
compared to only 66.66% from the pre program survey.

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

- 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."*

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

- 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."*



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

- 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.

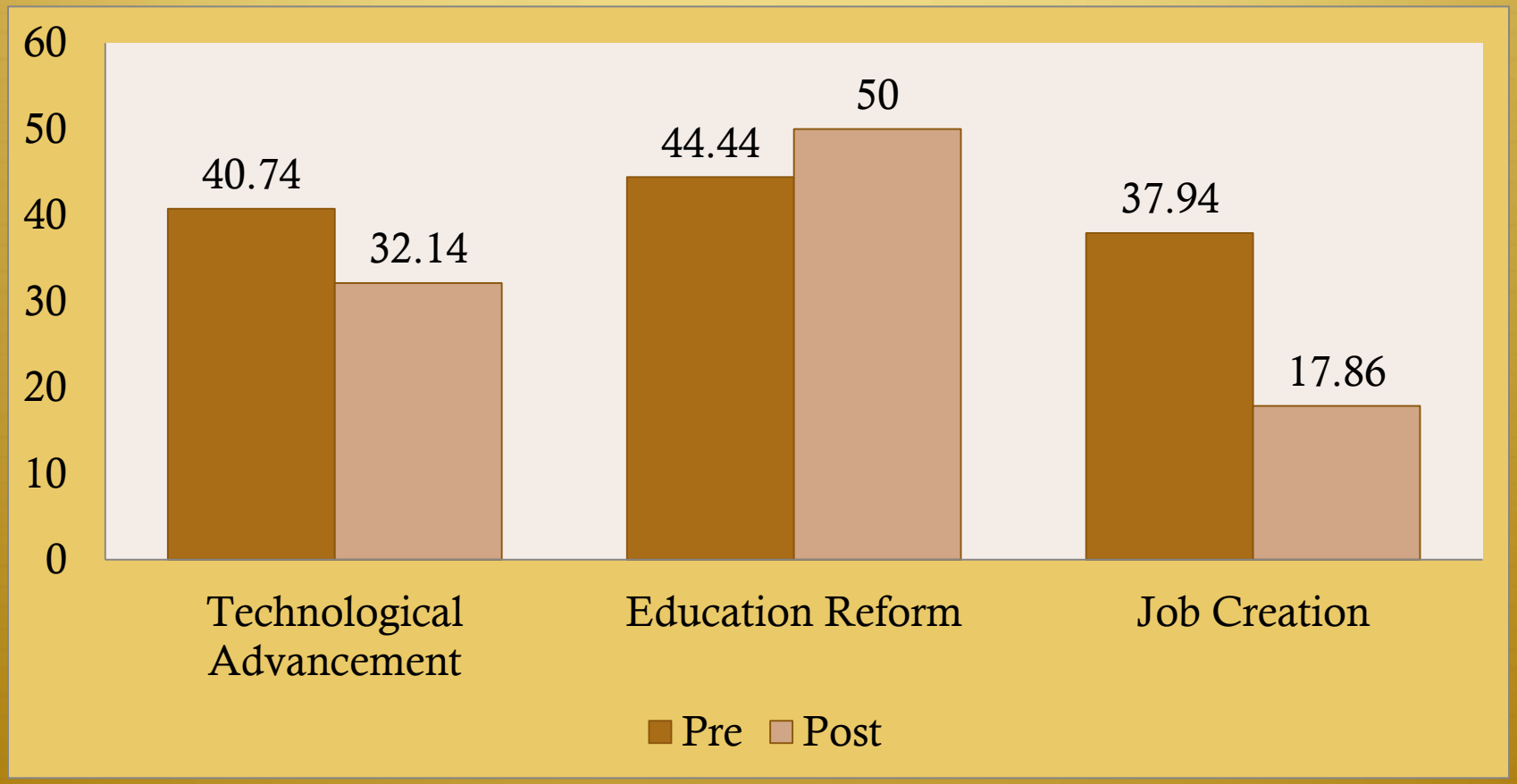
Limitations

- Time: 18 weeks, is insufficient to conduct and produce a more comprehensive longitudinal measure of the effectiveness of the Geo – STEM activities.
- Student interests: Not all students who participated in the study are interested in pursuing a geoscience career
- Student's access to certain websites is filtered

Conclusion

- Students shows a higher understanding of what STEM is about and it's importance not only to an individual but also to the educational reform and technological advancement in the country.

50% of students believe that STEM is critical to Educational Reform

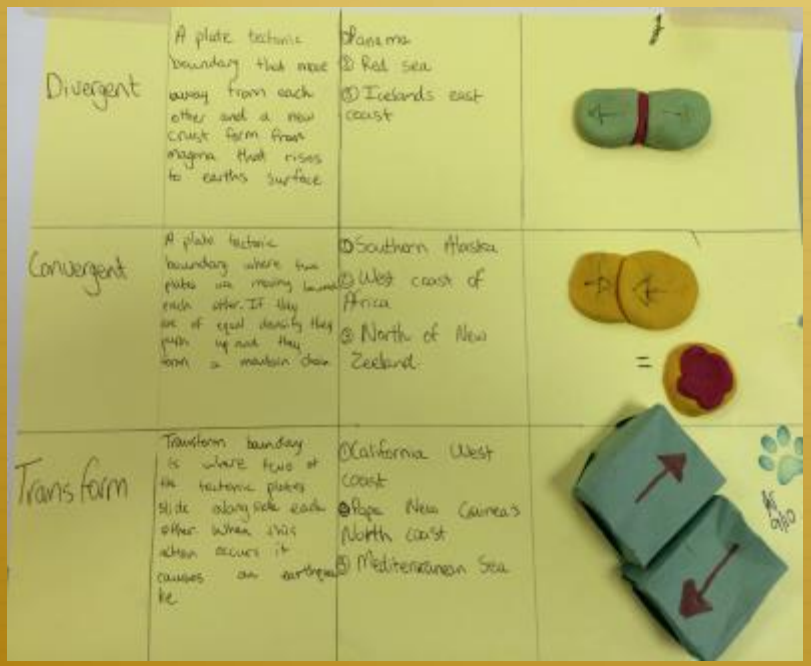


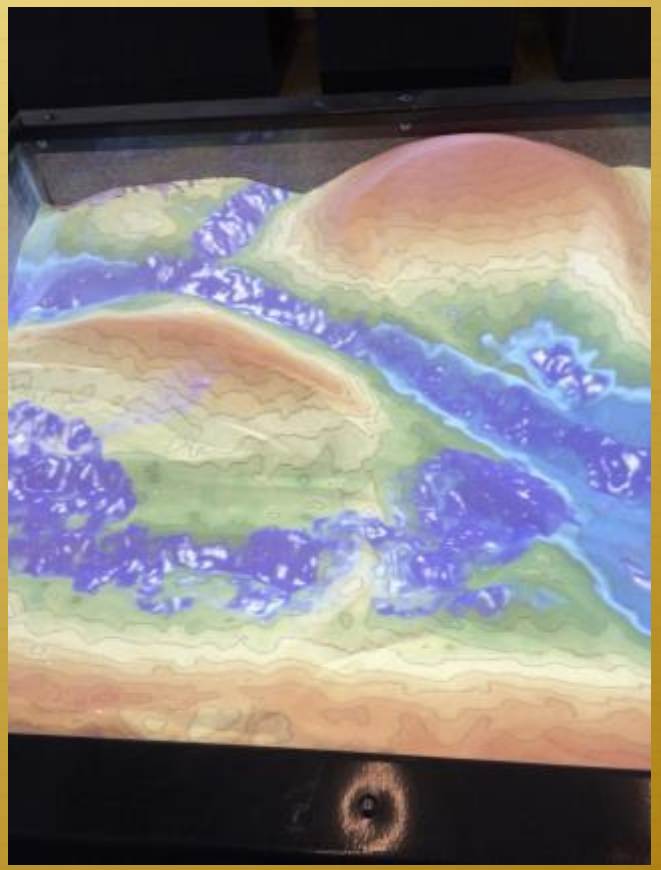
STEM Education

- The Geo – STEM Career Awareness program that was implemented can be seen as a content integration model of STEM education because…

STEM Education

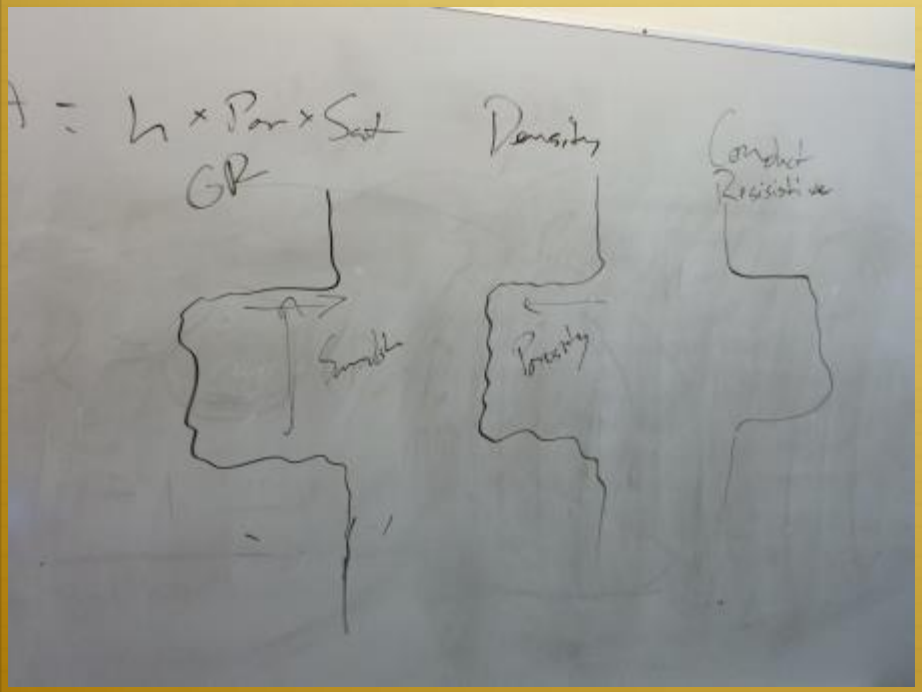
- It involves ideas, career awareness and knowledge as well as exposure to the real world and competencies from all STEM disciplines such as constructing of an artifact or models (Engineering)





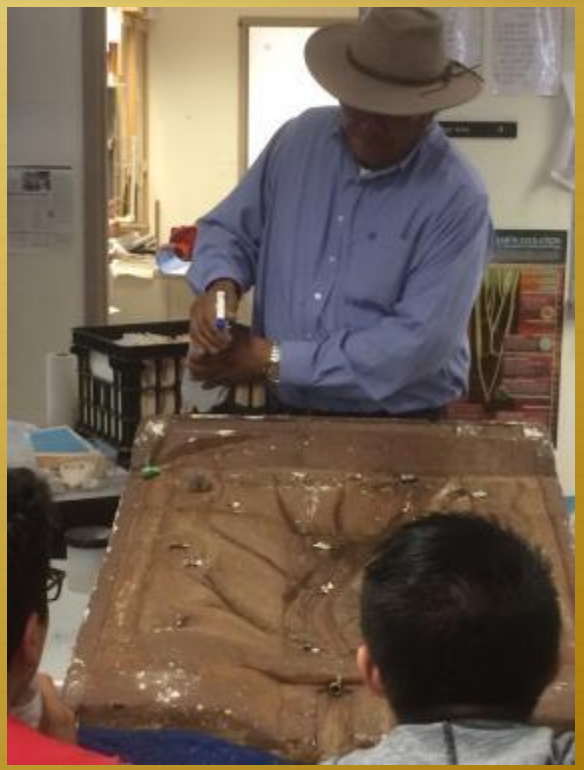
STEM Education

- It involves collection and analysis of data as well as the application of Mathematics to the oil and gas industry (Mathematics)



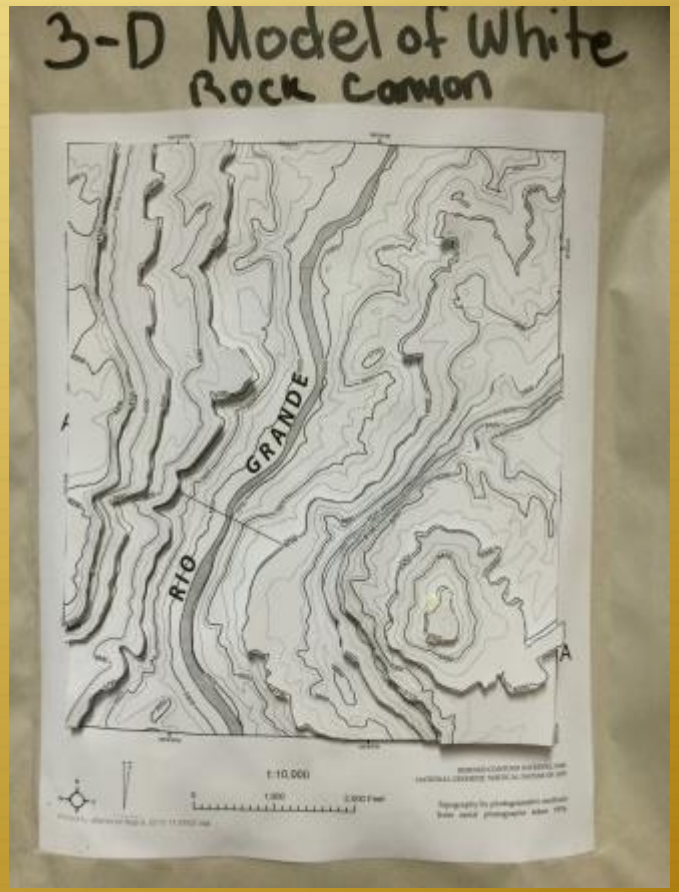
STEM Education

- It involves understanding the Scientific principles (Science):



STEM Education

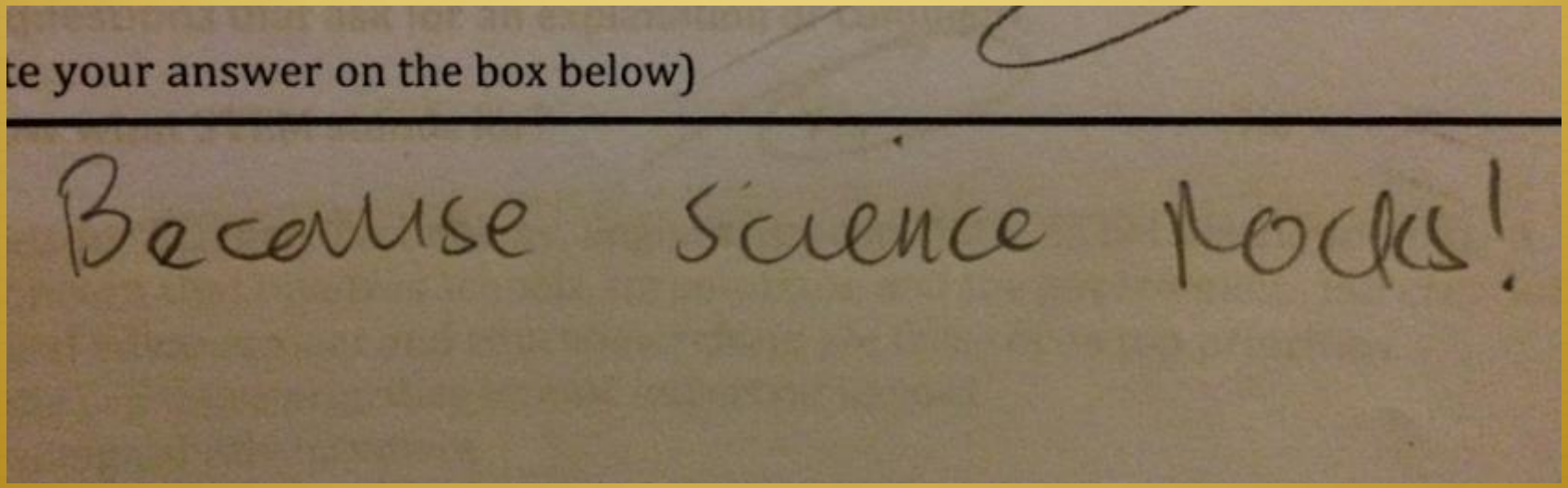
- It involves the use of Computer Technology to further understand mapping, GIS and similar tools for Geology (Technology).



Recommendations

- Availability of Professional Development in Geoscience/Earth Science is very limited for educators in the state of New Mexico.
- If there will be more available PDs for teachers on Geo – STEM or implementation of STEM in Geoscience and Earth Science subjects, we may see a rapid increase in Geoscience career interests in High School Students and a significant increase in students that may pursue a post secondary education in Geology or Earth Science fields.

Thank you!



Dr. Harisson, Dr Westpfahl, Dr. Chavez and Dr. Wolberg
And to my girls who has grown the love to hike with me… ☺

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