



SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS



STEM: A SET OF TOOLS FOR ANSWERING QUESTIONS AND SOLVING PROBLEMS.

1 INTRODUCTION

The acronym *STEM* applies to scientific & engineering work, potential careers, or education.[1] It all begins with a question to be answered or a problem to be solved. Below are a few example questions studied by KSC's Ecological Program:

1. How do plants respond to prescribed fire?
2. How does the Florida scrubjays respond to habitat changes?
3. How do sharks use the near-shore habitat?
4. Which beach habitats are favored by the south-eastern beach mouse?

2 SCIENCE

Science can be defined as a set containing knowledge, methods, and a way of understanding the natural world. Science helps us to answer questions about the natural world. Scientists look for relationships. Descriptions of relationships are called *Laws*, explanations for relationships are called *Theories*.[2]

3 TECHNOLOGY

Example: Global Positioning System (GPS) is used to acquire position data for surface and/or elevation. GPS allows mapping, modeling, determination of distances, areas, etc.



REFERENCES

- [1] R. W. Bybee. Advancing STEM education: A 2020 vision. *Tech. and Eng. Teacher*, 70(1):30–35, 2010.
- [2] N. G. Lederman. Nature of science: Past, present, and future. *Handbook of research on science education*, 2:831–879, 2007.

4 ENGINEERING

There are many kinds of engineers. Engineers solve problems, often by designing technological solutions. For example, electrical and materials engineers designed the GPS unit pictured in box 3. Other kinds of engineers designed the software that allows people to access and use the data acquired by the GPS unit.

Example: facilities at Kennedy Space Center are designed to handle any stormwater that is created by impervious surfaces, such as roof and parking lots. Engineers use mathematics to calculate required volume for stormwater retention and detentions areas, as well as flow for conveyances.

5 MATHEMATICS

The language of mathematics allows us to think about the natural world and its relationships objectively. Consider Newton's Second Law of Motion: $F = ma$. This equation describes a relationship between the acceleration of a mass, (a spacecraft), and the force acting upon that mass. This relationship lies at the heart of spaceflight.

Mathematics called *statistics* allows scientists & engineers to describe data, and allows them to infer the behavior of the natural world from sample data. Statistical models allow predictions to be made when random processes must be included.

6 AN EXAMPLE

In the following example see how a scientist uses *STEM* to answer a question about scrub habitat & sea level rise. Think about how an engineer might use *STEM* to solve a similar problem related to infrastructure, such as stormwater retention.

STEM AS OUR FUTURE

STEM is considered to be crucial to the economic future and security of the United States. To this end STEM literacy has been identified as a desired outcome of our education system. Education

7 SCIENCE QUESTION

How will sea level rise affect scrub plants required as habitat by the Florida scrubjays?

The picture to the right is an example of ridges & swales at KSC. Along the right side of the photo, beginning at the lower-right corner, you see standing water in the swale grading uphill to sandy scrub, which supports scrubjays. The white patches are bare sand, indicating dry scrub soils. As sea level rises, the groundwater that floods the swales will also rise, decreasing the area of soil that is dry enough to support scrub oaks.



How can *STEM* be used to help answer the question above?

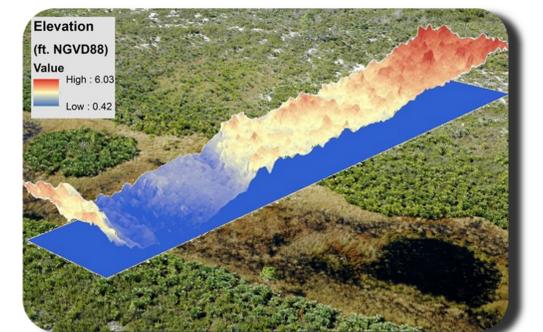
8 STEM TOOLS

SCIENCE: Used to formulate the question and a method with which to answer it.

TECHNOLOGY: Used to map the ground surface using LiDAR (a LASER-based kind of radar), to collect position and elevation data to allow ecologists to determine the lowest elevation above the water table at which scrub oaks live, to collect LiDAR data, and to create a 3-d model of ridge and swale surface with water table (see Figure to right showing ridge and swale with 3-d model insert), to raise the water table to quantify decrease in scrub habitat for any amount of sea level rise.

ENGINEERING: Many kinds of engineers designed all the technology that allows the collection and analysis of the data that can then be used to create a useful model.

MATHEMATICS: Used as statistics to allow inference from sample data to real world.



How might an engineering problem related to sea level rise be solved using the same general *STEM* approaches?

Higher water tables will decrease the ability of stormwater drainage to handle runoff from rains. This decrease can be determined using the same kinds of technology as outlined above.

FOR MORE INFORMATION

- Web** <http://missionstem.nasa.gov>
- Web** <https://nasa.gov/audience/foreducators>

standards and course requirements reflect the increased importance placed on STEM subjects in Florida's K–12 school systems.