TRANSFORMING MATHEMATICS ACTIVITIES INTO STEM ACTIVITIES

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INTRODUCTION

Discuss with those sitting near you:

- What does it mean to “integrate” STEM subjects in a math classroom?
- What experiences with STEM integration do you have?

GEOPANES ACTIVITY

- You will be working in groups of 4-5
- Two groups per pail; each group gets a baggie
- Do not dip your shapes until you have filled out your table, finalized your prediction, and written it down!
- Before you make your prediction, I want you to think about the science concept of surface tension, and the mathematics concept of surface area.

TERMINOLOGY

- Two dimensions
  - Vertex
  - Side/Edge

  - Perimeter
  - Area
  - Shape
  - Polygon

- Three dimensions
  - Vertex
  - Edge
  - Face
  - Surface Area
  - Volume
  - Solid
  - Polyhedron

Polyhedron: a 3 dimensional solid with flat faces and straight edges – i.e., faces are made up of polygons

What are some examples of familiar 3-dimensional shapes that are not polyhedra?

WHAT HAPPENED??

- Who will share their scientific explanation of what happened when you dipped your geopanes?

- Resources:
  - The geometry of soap bubbles: http://www.soapbubble.dk/en/bubbles/geometry.php
  - The science of soap bubbles: http://www.exploratorium.edu/ronh/bubbles/soap.htm

AN EXPLANATION

- **Surface area** - The total area of a 3 dimensional object's faces and curved surfaces
- **Surface tension** – molecules at the surface of a liquid do not have molecules on all sides of them, and that makes them cohere more strongly to those that are near them. These molecules have **higher energy** as a result.
- In other words, the water molecules are much more attracted to each other than to the air – they want to stay as close together as possible
- The greater area of the surface of the water, the more high energy molecules that don't have molecules all around them you have. Therefore the film deforms to minimize its surface area and, thus its energy.
- Surface tension too strong in pure water– it wants to be together in a single droplet, not stretched out. With soap, a sphere is the minimal surface to enclose the air.
- Hot water is better at cleaning because the lower surface tension makes more able to get into pores and fissures rather than bridging them. Soaps and detergents further lower the surface tension and prevent evaporation.

APPLICATIONS

- You can mathematically prove that the geopane formed by your soap film is the minimum possible surface area for a given set of vertices
- The minimal surface formed by the soap film has only tensile forces – no compression or bending
- This make it very useful for architecture – tensile roofing structures

https://en.wikipedia.org/wiki/Tensile_structure

EXTENSIONS

- What is the relationship between vertices, edges, and faces in polyhedra?
  - Euler characteristic: Vertices + Faces – Edges = 2
- What is a ***<u>regular polyhedron</u>***? (a.k.a. Platonic Solids):
  - (1) Each face is the same regular polygon
  - (2) convex
  - (3) same number of faces come into each vertex
- Which solid that you built is the most stable? Which is the least stable? Why?
  - In a square, the angle between the structural members can change without having the length of the members change or bend.
  - The angle between two sides of the triangle is based on the length of the opposite side of the triangle. This is why a triangle cannot collapse.

STEM INTEGRATION

- Discuss with your group:
  - How did this activity involve STEM integration?
  - What did you notice about the approach this activity took to integrating STEM?
  - Do you think the integration enriched the activity for you as a student?
- The version of this activity online involved none of the questions I posed on your sheet. How do you think this activity would have been different if enacted as the creators intended?
- Clean up all of your materials
- Original Activity available at http://gemsclub.org/yahoo_site_admin/assets/docs/Geopanes4395625.204104818.pdf

HOW TO START INTEGRATING STEM

1) Take a solid mathematics lesson that involves some sort of natural, physical, or technological phenomena, or a design challenge
   - Natural phenomena (biology, chemistry): nature/weather, chemicals/mixtures, the body and its systems, CSI, etc.
   - Physical phenomena (physics): Motion, travel, vehicles, astronomy
   - Technological phenomena: robots, programming, logic/rules
   - Design challenge (engineering): Design a soda can, packaging, house/classroom, garden; optimization problems
2) Determine the relevant science/engineering/technology standards that could be integrated with the lesson (e.g., NextGen Science standards)
3) Research the topic in the other discipline yourself, or get a collaborator
4) Determine key points in the lesson where additional STEM concepts can be woven in, not just as an "add on," but to meaningfully help learners understand the problem or phenomena better

STEM INTEGRATION IS…

- Using the perspectives of **multiple** STEM disciplines to better understand a problem
- Bringing to the **forefront** the vocabulary, practices, concepts, terms, and standards from multiple disciplines
- A practice that requires some **research**/**preparation**/**collaboration** to implement
- A way to **enrich** the mathematics lessons you already teach, giving them greater **relevance**
- A way to enhance **problem-solving** and **critical thinking** in your classroom

STEM INTEGRATION ISN'T…

- Using all 4 disciplines, all the time
- Doing numerical calculations as part of a science lesson
- Doing a mathematics lesson where data is collected
- Doing a math or science lesson on a computer
- Only for teachers who are experts in science and engineering
- A way of teaching less math, or teaching it less rigorously
- A way to not teach science in grade levels where it is not tested

DISCUSSION

- Should mathematics teachers be integrating STEM, and if so, how often?
- What would you need to be able to successfully integrate STEM in your classroom?
- What challenges might students experience with integrated STEM lessons?

RESOURCES FOR STEM INTEGRATION IN MATHEMATICS

- Model-eliciting activities:
  - http://www.cpalms.org/CPALMS/MEA.aspx
  - https://engineering.purdue.edu/ENE/Research/SGMM/CASESTUDIESKIDSWEB/case_studies_table.htm
- Buc Institute: http://bie.org/project_search/
- City Technology: http://citytechnology.org/
- Spark 101 Mathematics: http://www.spark101.org/math/

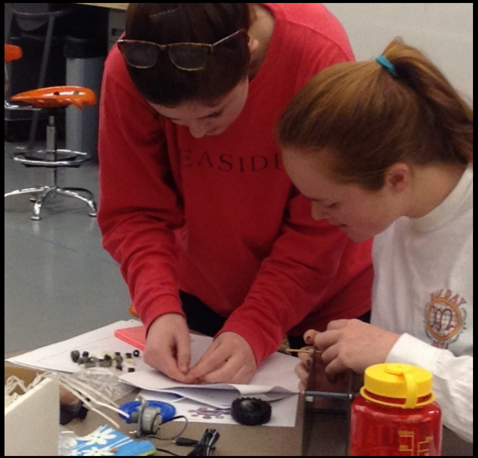
MASTER STEM TEACHER PROGRAM AT SMU

- Take 4 courses in K-12 STEM teaching:
  - The Science of Learning in STEM
  - Designing & Making in STEM
  - Algebra/Statistics for STEM integration
  - Project-Based Learning in STEM
- STEM field experiences in Dallas community, cutting-edge technologies
- Courses count towards a Master's degree in Education
- **More information:** cwalkington@smu.edu or https://www.smu.edu/Simmons/AreasOfStudy/TL/GraduatePrograms/MSTEMOverview




MASTER MATHEMATICS TEACHER PROGRAM AT SMU

- Take 4 courses in K-12 mathematics teaching at SMU, and receive a "Master Mathematics Teacher" certificate
- Courses provide resources for hands-on learning, student assessment, and engaging mathematical tasks
- Courses also count towards a Master's degree in Education
- **More information:** cwalkington@smu.edu or www.smu.edu/mmt



PARTICIPATE IN RESEARCH!

- Seeking middle and high school mathematics teachers
- Teach in large public schools
- Interventions related to pre-algebra, algebra, and geometry that enhance students' interest and learning
- Contact: cwalkington@smu.edu