



Engaging Non-STEM Majors in Authentic Problem Solving

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Problem: Learning objectives for non-majors intro science courses at Truckee Meadows Community College state that students gain critical thinking / scientific thinking skills, but the courses are taught as encyclopedic surveys of factual knowledge.

Trial Solution: PHYS 117 *Intro to Space Science & Engineering* a hands-on, project based science course for non-majors.

Critical thinking occurs when students are engaged in authentic problem solving.

What is an Authentic Problem?

An authentic problem ...

- is real and unsolved
- is not trivial (solution takes many iterations)
- requires balancing multiple competing constraints
- and has solutions that must be "graded" by evaluating performance in the real world

Example from High Altitude Ballooning Project -
Image taken from student built payload 93,343 feet
above Pyramid Lake and the Black Rock Desert.
Reno, NV and Lake Tahoe are seen in the distance.



Example Class Projects:

- Lighter-than-Air Vehicles¹ (*Physics of Flight & Control Systems*)
- High Altitude Ballooning² (*Space Environment & Systems Engineering*)
- High Powered Rocketry³ (*Remote Sensing & Telemetry*)
- Model Rocketry⁴ (*Numerical Modeling, Operations & Logistics*)
- LEGO Robotics⁵ (*Motivation & Execution of Semi-Autonomous Exploration*)

For each project students work thru a complete design cycle of ...

1. design / build
2. deploy / execute
3. reflect / evaluate

Students individually submit technical papers for the evaluation phase of each design cycle.

¹Dava Newman, *Interactive Aerospace Engineering and Design*, McGraw-Hill 2001.

²Chris Koehler, *Edge of Space Science*, <http://spacegrant.colorado.edu/index.php/demosat-project>

³Bob Twiggs, *ARLISS Project*, <http://www.arliss.org/p/about>

⁴NASA Beginner's Guide to Rockets, <http://www.grc.nasa.gov/WWW/K-12/rocket/bgmr.html>



Student built Lighter-than-Air Vehicle completing a timed-trial during an all-campus competition.

High Altitude Ballooning: A Closer Look at One Project

Is the project **Authentic**?

- Real science is still done on high altitude balloon platforms.
See for example Feb. 23, 2011 press release http://www.spacemart.com/reports Revolutionary_Design_For_Stratospheric_High_Altitude_Balloon_Missions_999.html
- Student payloads fly to 100,000 feet and are exposed to the near space environment.
- Optimal payload design depends on mission specific objectives. So no single best solution exists.
- Student payloads must meet FAA established constraints on mass and materials.
- Project deadline is defined by a wind/weather specific flight window.

Are students engaged in **Critical Thinking**?

- Students evaluate payload designs from previous classes.
- Students must balance i.) mass limitations vs survivability of payload and ii.) protecting against near space environment vs access to near space environment for data acquisition.
- Optimal payload design depends on mission specific objectives. So no single best solution exists.
- Post flight, students conduct a performance analysis of their payload designs.