Exploring the Edge of Space: Streamlining Physics and Earth Science Collaboration in a new Community College Course

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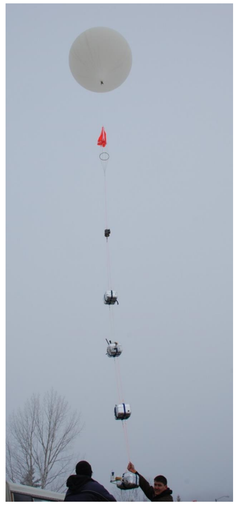


Abstract

We designed a new lab science course on stratospheric ballooning (SB), titled Exploring the Edge of Space. The course, which starts in the upcoming semester, brings together two groups of students simultaneously: Mainstream liberal arts students and students in the college's Honors program. The Honors students meet an additional hour weekly, review scientific literature extensively, and complete a capstone project. The course design is a collaboration between the physics and earth science departments at Central Lakes College, and is drawn on the five-year experience of the authors doing SB flights, many in collaboration with the Bemidji State University SB program. Unlike the past SB flights based on a semester project within pre-existing course curricula, the SB project is the kernel of this course. Therefore it will allow students to focus on learning the knowledge, skills, and attitudes necessary for the success of a large science-technology project while also fulfilling the outcomes to assure transferability. Those students who complete the major project activities including, but not limited to, developing experiment and revising draft reports will achieve the learning outcomes in the goal area of Natural Science of the Minnesota Transfer Curriculum as well as some of the Undergraduate Physics Laboratory Curriculum recommended by the American Association of Physics Teachers. Past experience has shown that students need to spend considerable time building competency in the areas of working in teams with diverse groups, working with technology, critical thinking, complex problem solving, written communication, applying knowledge in field situations, and science literacy in both earth science concepts and research. This course will focus on developing those skills, in an entirely inquiry-based, workshop-lab environment. Students will be guided through the learning of essential concepts, and supported in doing their own research, project development, and experimental design.

Introduction and rationale for new course

Since Fall semester, 2010, Central Lakes College HAB flights have collaboratively involved students in the following Geoscience and Physics/Engineering department classes:

- Earth Science and the Environment
- Astronomy
- Nobel Conference Honors Cosmology
- Honors Earth Science and Environment
- Concepts of Physics
- Honors Physics/Astronomy
- College Physics I & II
- Classical (Engineering) Physics I & II
- Circuit Analysis I & II
- Dynamics

Nine of the flights have been with collaboration and support of Bemidji State University.

The HAB projects at CLC meet the following geoscience course outcomes:

- Correctly operate modern field and laboratory analytical equipment.
- Perform field based investigations using standard geoscience techniques.
- Describe and explain observations in the context of contemporary Planetary and Geoscientific theories.
- Demonstrate written communication skills in science lab reports.

HAB projects at CLC also have the following components:

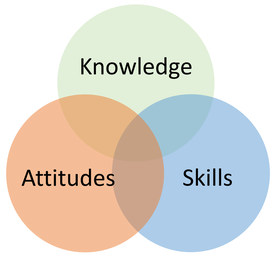
- They attempt to provide an authentic geoscience research experience, involving hypothesizing, experimental design, fieldwork, experience with GIS, and data collection and analysis.
- Interdepartmental and intercollegiate collaboration, and student teamwork
- Outreach and STEM recruiting

Knowledge

- Applied geoscience and physics
- Applied physics: mechanics, fluids, electricity, radiation

Attitudes

- Persistence
- Commitment to accuracy
- Questioning
- Openness to observation through all senses.
- Willingness to work in an environment of uncertainty
- Continuously learning



Skills

- Thinking and communicating with clarity and precision, in writing and speaking.
- Keeping a notebook-recording observations, design plans, etc.
- Reading and following step-by-step instruction
- Basic numeracy and calculation
- Thinking critically, interdependently, flexibly, reflexively
- Working with others in teams
- Locating, organizing, evaluating information
- Being innovative, creative
- Analyzing and solving complex problems
- Transfer: applying past knowledge to new situations
- Working with one's hands, guided by the mind.

Overarching Course Goals

In this course students will,

- Demonstrate understanding and application of select topics in geoscience, physics, and technical (electro-mechanical systems?);
- Apply the process of experimental design to carry an idea from hypothesis to working scientific experiment.
- Apply their understanding of balloon systems to execute a successful stratospheric balloon flight.
- Honors students will demonstrate their ability to independently plan, and produce a capstone project of their own design, appropriate to the institutional honors designation.

Course Outcomes

Minnesota Transfer Curriculum (MnTC) & some AAPT Undergraduate Physics Outcomes

MnTC	• Demonstrate understanding of scientific theories • Evaluate societal significance of experiments in atmospheric science • Formulate hypotheses
MnTC and AAPT	• Present results and ideas with reasoned arguments supported by experimental evidence and utilizing appropriate and authentic written and verbal forms • Analyze and display data using statistical methods and critically interpret the validity and limitations of these data and their uncertainties • Collect, analyze, and interpret real data from personal observations of "the physical" world to develop a physical and geoscientific worldview • Develop, engineer, and troubleshoot experiments constructed for testing models and hypotheses while working within specific constraints such as cost, time, safety, and available equipment
AAPT	• Become proficient using common test equipment in a range of standard laboratory measurements while being cognizant of device limitations • Develop abstract representations of real systems, study them in the laboratory, seek to understand their limitations and uncertainties, and use their models to make predictions
Honors	• Compose a summary report of their independent research of scientific literature; • Critically discuss scientific topics; and • Independently conduct an original capstone project, that embodies the spirit and purpose of the honors designation.

Honors program at CLC

Courses in the Honors Program emphasize independent inquiry, informed discourse, and direct application within small, transformative, and seminar-style classes that embrace detailed examinations of the material and feature close working relationships with instructors. In addition, students learn to leverage course materials so that they can affect the world around them in positive ways. Activities may include (original) research, inquiry based investigation(s), collaboration, or other project types that the instructor deems worthy of the Honors' designation.

Assessment Instruments

Whole Class

- Reports
- Poster presentations
- Reading notes
- Research/design notes
- Design and develop experiment
- Literature review

Honors

- Reports
- Capstone project
- Extensive literature review

Tentative course outline for Fall Semester, 2016

Weeks 1 – 4
Background concept building, team building, developing and building SB experiment, learning about SB launch, flight, and recovery systems.
Honors: Submit reference list and draft literature review of independent library research.

Week 5
Experiment assembly and testing.

Week 6 (end of September)
Tethered launch on Central Lakes College campus grounds.

Week 7 (first week in October)
Target lauch date for SB flight
Honors: Submit literature review of independent library research.

Week 8 (mid-semester)
SB flight debrief and cleanup. Begin data analysis and report writing.

Weeks 9-12
data analysis and scientific report writing continued.

Week 13 (mid-November)
Intro do scientific posters and poster sessions.

Week 14
Draft report due for instructor comment. Continue working on poster.

Week 15
Data analysis, report writing, designing and making scientific poster
Honors: Independent research report draft due for instructor comments.

Week 16 (last week of class)
Team scientific poster due at end of week for printing and assembly.

Week 17 (final exam week):
All reports due. Scientific poster session share fair on scheduled final.
Honors: Independent research report and capstone project report due