High Altitude Ballooning in High School Science Classes

Academic High Altitude Conference
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D. Takehara, J. Dailey, S. Gavin, S. Snyder, B. Smith – Taylor University; J. Krueger – StratoStar Systems, LLC

Making a Difference (MAD)

- *Rising Above the Gathering Storm, Revisited* 2010, National Academies (Sciences, Engineering, Institute of Medicine)
  - Only 4% of U.S. workforce is in the sciences or engineering
- How can we make a difference?
  - Engage our youth at an early age in science
- How do we engage our youth?
  - Project based learning with real world application

High Altitude Ballooning!

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Ballooning with 375 High School Students

Marion High School (Marion, IN) Classes

- Advanced Placement Chemistry
  - Spring 2011 (20 students)
  - Spring 2012 (20 students)
- Chemistry II
  - Spring 2012 (60 students)
- Integrated Chemistry & Physics (ICP)
  - Fall 2011 (275 students)

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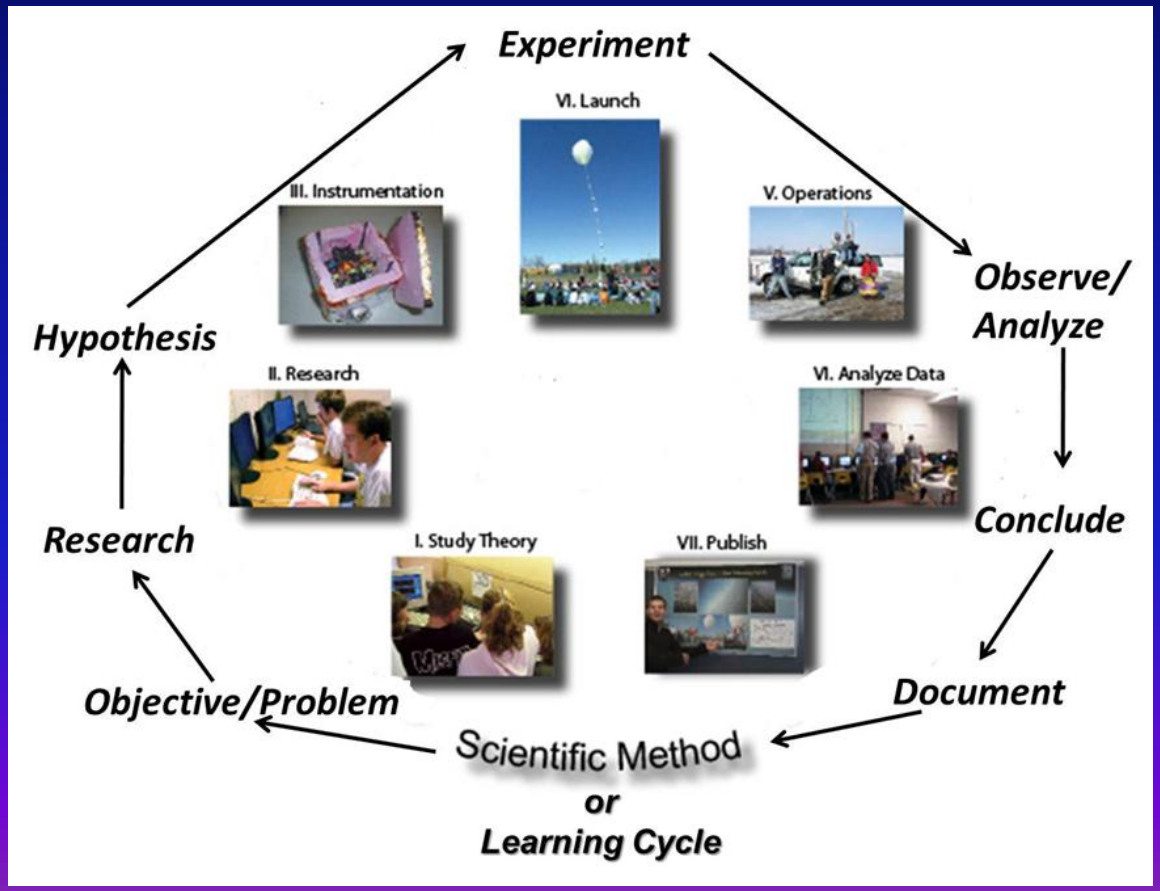
AP Chemistry

- Post AP Exam project
- Scientific Method - hands-on engagement
- Students
  - formulate hypothesis
  - develop experiment
  - perform experiment
  - analyze data
  - draw conclusions
  - present findings



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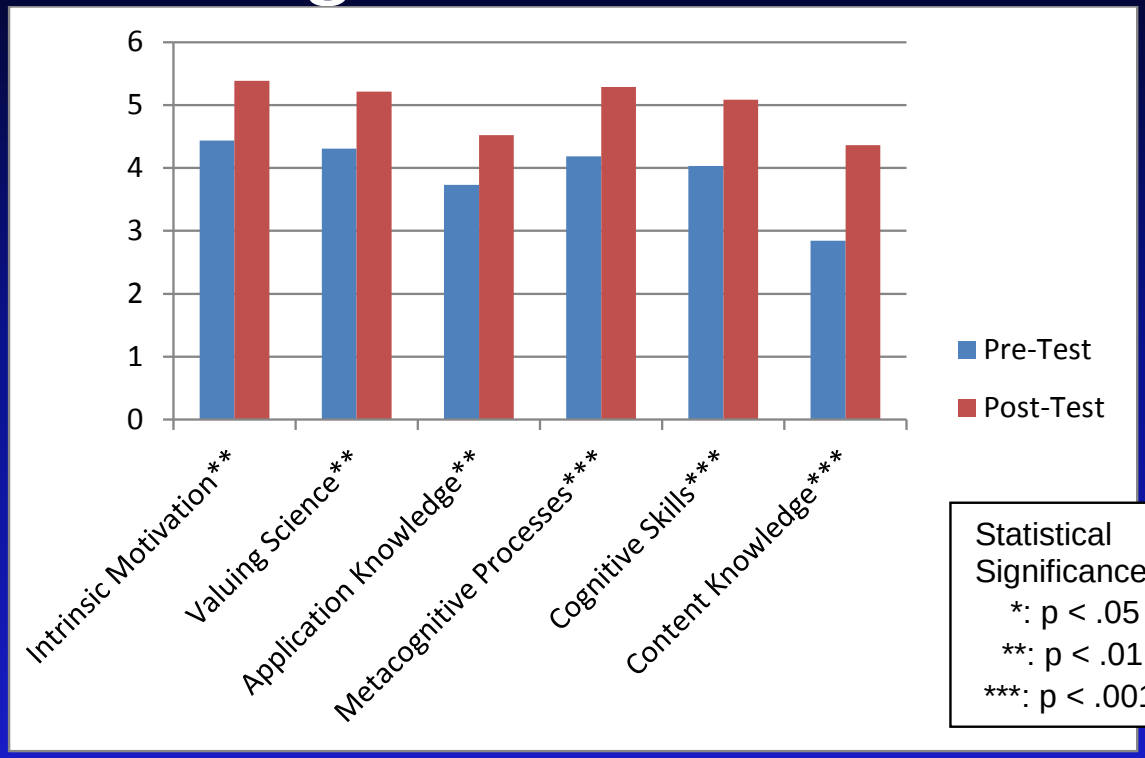
Learning Assessment

- **Intrinsic Motivation** - contextualization, curiosity, challenge, control, and cooperation.
- **Valuing Science** - valuing problem solving, calibration, the scientific method, reproducibility, data analysis, metacognitive planning, monitoring and assessing, teamwork, and meeting deadlines.
- **Application Knowledge** - how to use problem solving, prototyping, evaluating, calibrating, and documenting.
- **Metacognitive Processes** - planning, monitoring, and assessing ones thought processes.
- **Cognitive Skills** - application of the following (Application Knowledge) to a complex problem at the appropriate time: problem solving, prototyping, evaluation & calibration, the scientific method, reproducibility, and data analysis.
- **Content Knowledge** - knowledge of the scientific method, the technical balloon launch process, and the requirements for a balloon launch.

AP Chemistry – Spring 2011

Learning Assessment Results



Practical Significance

Intrinsic Motivation **(eta² = 0.67)**
Valuing Science **(eta² = 0.65)**
Application Knowledge **(eta² = 0.64)**
Metacognitive Processes **(eta² = 0.82)**
Cognitive Skills **(eta² = 0.78)**
Content Knowledge **(eta² = 0.90)**

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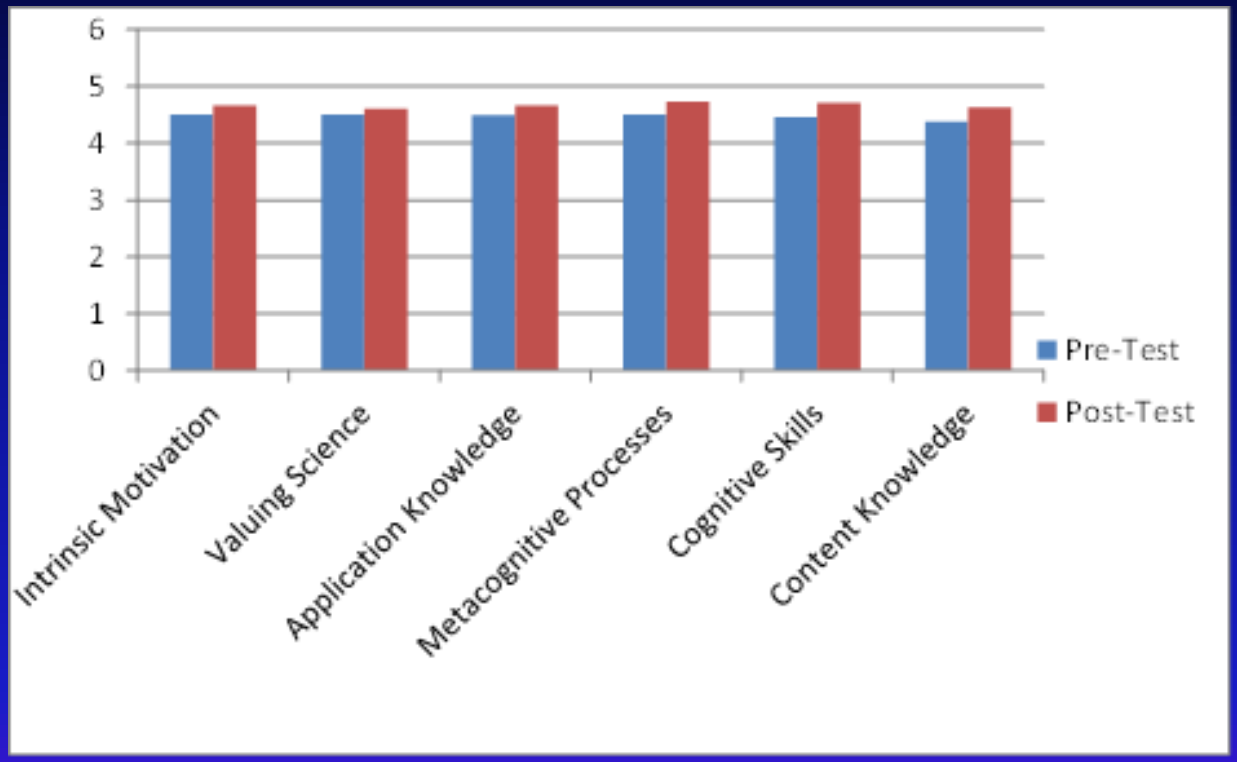
AP Chemistry – Spring 2012

- New teacher
- Learning Assessment – insufficient data
- Students were engaged
- Students feedback - one of better projects
- Teacher – would like to do again next year

Chemistry II

- Nuclear Chemistry Application
  - Shielding of radioactive particles
- In Class Teaching of shielding
  - Alpha, beta, gamma sources
    - Impact of size and charge
  - Geiger counter on balloon
  - Demo different shielding materials
    - Paper
    - Al foil
    - Lead foil
  - Students bring in and try shielding materials
- Radiation on Balloon
  - Research on internet
  - Competition
    - Each class choose one shield to test on balloon
    - Winning class gets Pizza Party

Chemistry II
Learning Assessment Results



Statistically significant changes in the following:

- **Curiosity (subgroup of Intrinsic Motivation) – $p < 0.05$**
- **Monitoring (subgroup of Metacognitive Processes)– $p < 0.05$**
- **Prototyping (subgroup of Cognitive Skills) – $p < 0.01$**

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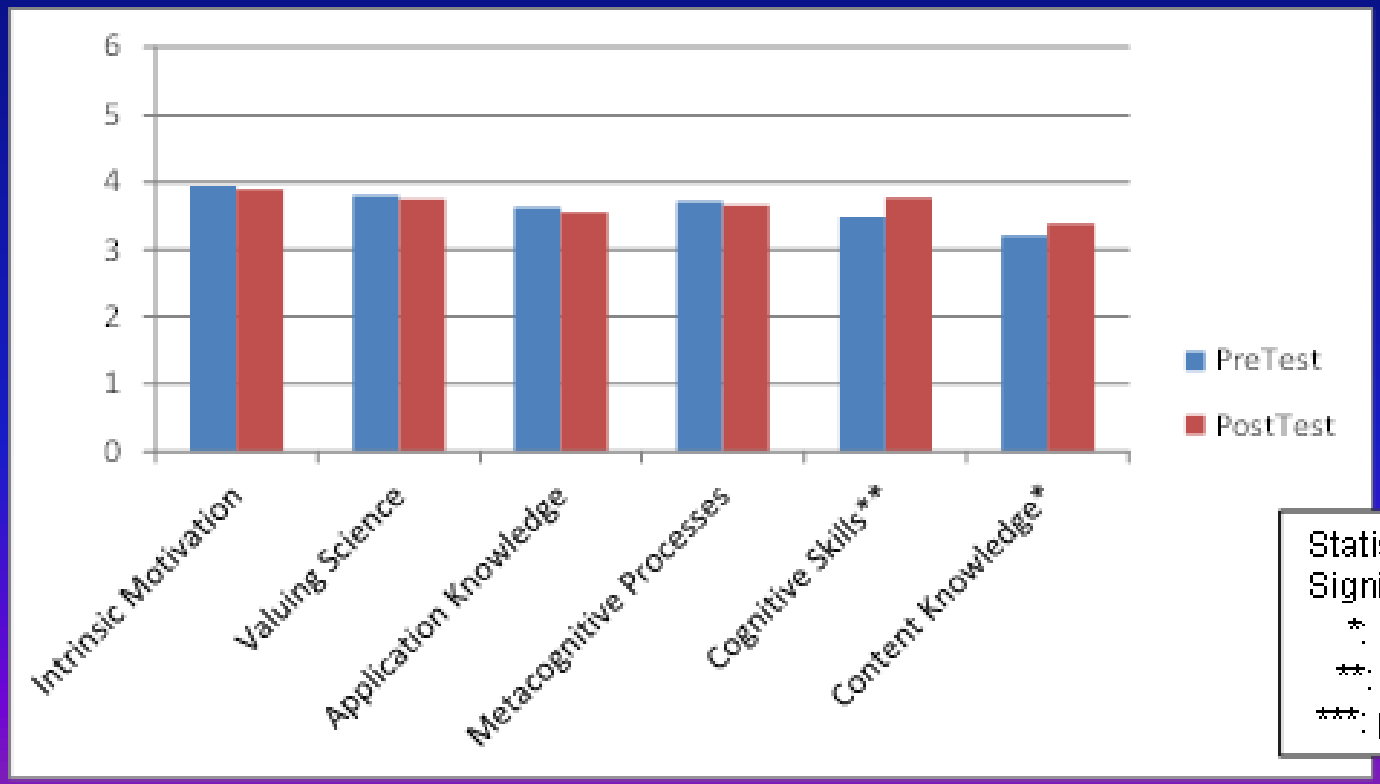
Integrated Chemistry & Physics (ICP) 275 Students

- Beginning of year – “engage the students”
- Inquiry based – “What would happen if…?”



Learning Assessment

Learning Outcomes Increase with Number of Implementations

EVENT GROUP	NOVICE GROUP	EXPERIENCED GROUP	EXPERT GROUP
Intrinsic Motivation	Intrinsic Motivation	Intrinsic Motivation	Intrinsic Motivation
Valuing Science	Valuing Science	Valuing Science	Valuing Science
Application Knowledge	Application Knowledge	Application Knowledge	Application Knowledge
Metacognitive Processes	Metacognitive Processes	Metacognitive Processes	Metacognitive Processes
Cognitive Skills	Cognitive Skills	Cognitive Skills	Cognitive Skills
Content Knowledge	Content Knowledge	Content Knowledge	Content Knowledge

Group Definitions

Event: Demo Only
Novice: 1 class
Experienced: 2-3 classes
Expert: > 3 classes

Black: $p > .05$
Red: $p < .05$
Green: $p < .01$
Blue $p < .001$

Above includes:

- 20 Undergraduate Classes
- 526 Students

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Conclusions

- AP Chemistry
  - "off the chart" learning assessment results
- Chemistry II & ICP
  - Statistically significant outcomes in some areas
- Encouraging results – especially for 1st implementations
- High Altitude Ballooning – promising for engaging and teaching science in high school

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Future Work

- Continue implementation at Marion High School
  - Teachers desire to repeat in 2012-2013
- NSF Grant Opportunities
  - Discovery Research K-12 (DRK-12)
  - Math and Science Partnership (MSP)

Thank You

- Taylor University for financial support and encouragement
- Marion High School Teachers and Administration for great partnership