Progressing Science, Technology, Engineering, and Math (STEM) Education in North Dakota through Near-Space Ballooning

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Academic High Altitude Conference
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Past Experience

- Bachelor's in Astronomy, minored in Education.
- High school Earth Science teaching license (MA)
- Attended first HAB launch fall 2011
- Obtained my HAM radio license 2012
- Organized UND's local launches, Kempton, ND
- Team lead on UND's High Altitude Student Platform (HASP) team 2011-2013
- Coordinator of the 2012-2013 Near Space Balloon Competition (NSBC)
- Thesis work 2013-2014

Introduction

- Master's thesis project
  - 8th grade Earth Science class (124 students) at Valley Middle School
  - Integrated a high altitude balloon mission into their curriculum – astronomy, meteorology, remote sensing
  - Evaluated the students with a pre- and post-survey
- Wanted to this to complement yet contrast NSBC
  - Kids are already interested in STEM activity

Near Space Ballooning

- Here at UND:
  - Helium, latex Kaymont balloons (1500 grams)
  - Safety launch regulations:
    - Federal Aviation Administration (FAA)
      - NOTAMs
    - Federal Communications Commission (FCC)
      - HAM Radio Operators
    - UND Flight Safety Office (FSO)
      - In 2012, GFK was ranked 17th busiest airport in the country

http://www.grandforks.org/pages/success_story?r=7E2QJ8J9CT

Hypothesis

Middle school students who have practiced the scientific method in a real world application of Near Space Ballooning will have an increased affinity to STEM subjects.

Methods

- *Participants*
  - 124 participants (54% female, 46% male)
  - All were students from Brent Newman's 8th grade Earth Science classes (Valley Middle)
  - Voluntarily completed the surveys
  - Identities were kept anonymous
    - Used background demographics to compare data

Methods

- *Procedures*
  - In 12 teams, participants were expected to create experimental payloads
    - Hypothesis
    - Design
    - Construct
    - Launch and Chase
    - Data Analysis
    - Final Report

Methods

- *Measures*
  - Pre- and post- surveys
  - UND IRB permissions (IRB-201310-142)
  - Participation consent and assent form (13-14 years old)
  - The analysis was performed by:
    - Likert Scale – style questioning
      - (Strongly disagree, disagree, neutral, agree, strongly agree)
    - Weighted Average
    - Student's t-Test (Welch's)
      - two population variances are not equal

Results

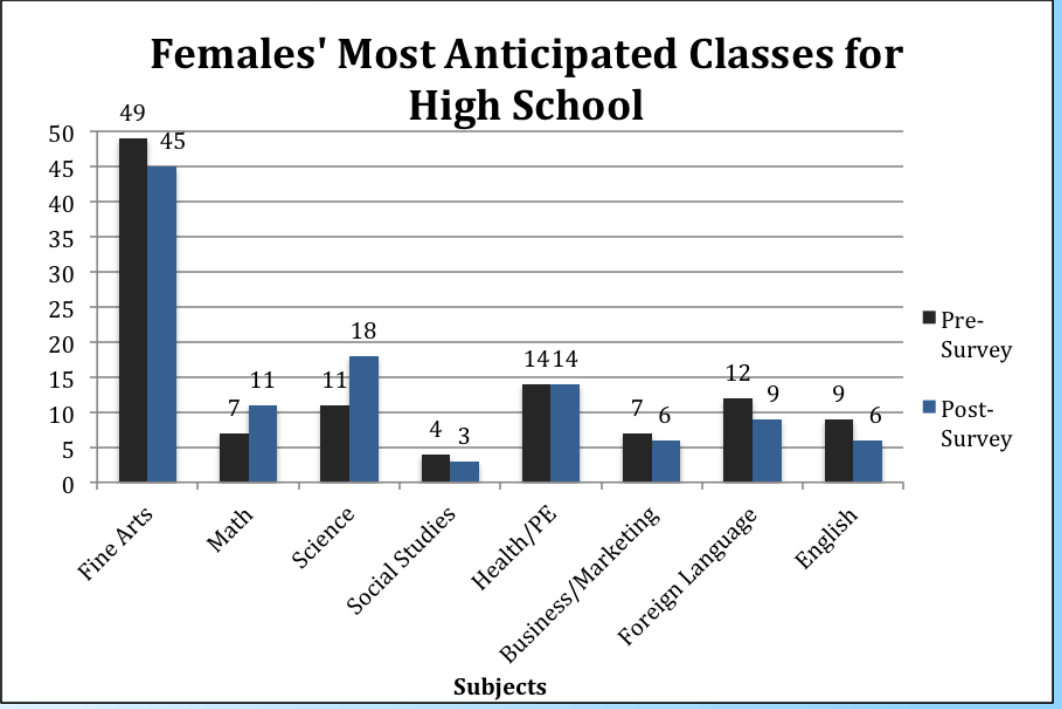
- The t-test was calculated with alpha set at 0.05.

1. The result of the “I Think Engineers Work Alone” survey question demonstrated a statistically significant change, supporting the hypothesis.
   ($\bar{X}_1$= 2.44, n = 118; $\bar{X}_2$= 1.86, n = 113; p = $1.16 \times 10\text{-}6$, α = 0.05)
2. The remaining seven Likert-scale Student Response questions demonstrated no significant change, supporting the null hypothesis.

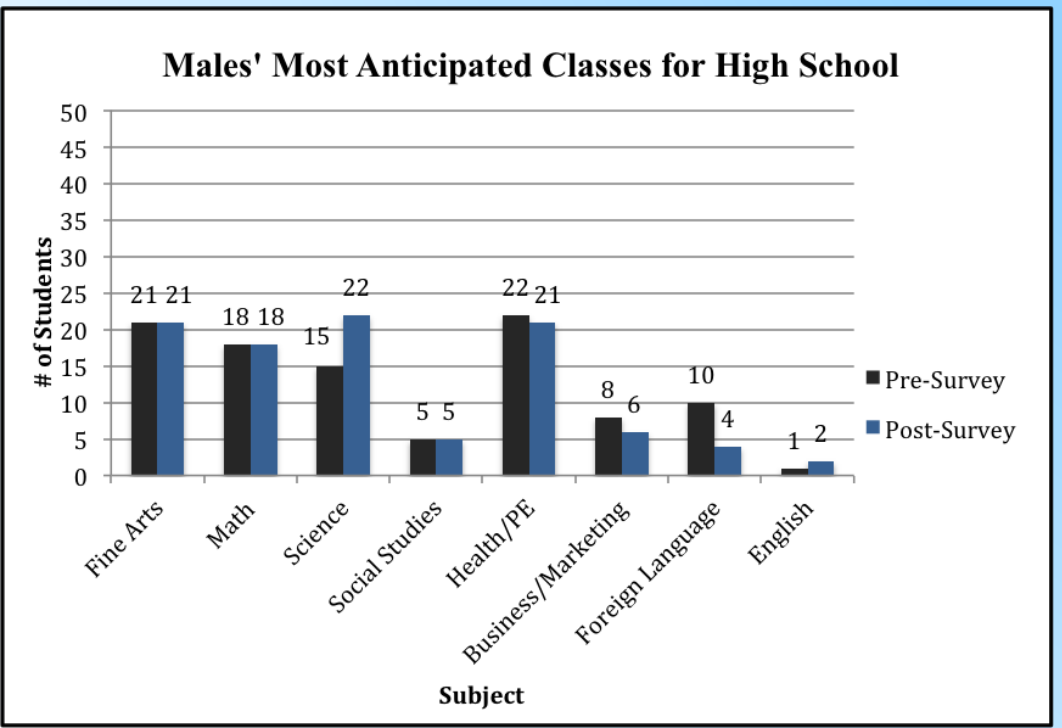
Results

The following survey questions displayed no statistical change from the pre- to post-survey.

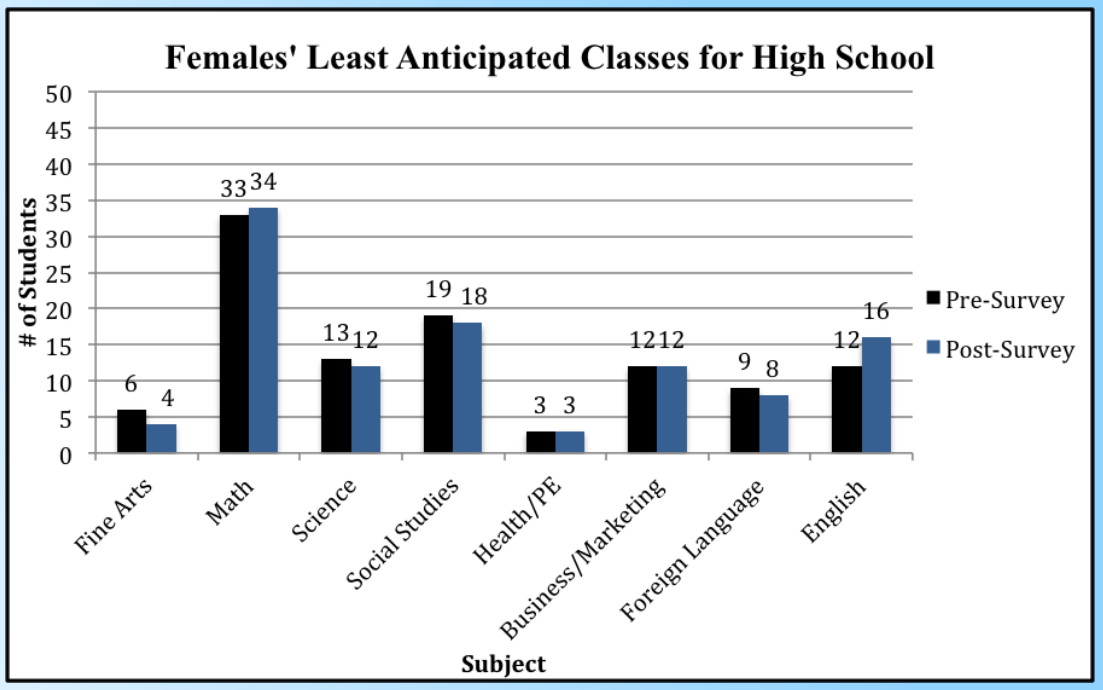
1. I think Astronomy is interesting – Agree
2. I want to go to college – Strongly Agree
3. I would like to attend UND – Neutral
4. I plan on joining an extracurricular activity in high school – Neutral
5. I wish to get a job in a science field when I'm older – Neutral
6. I have a specific career in mind - Agree
7.



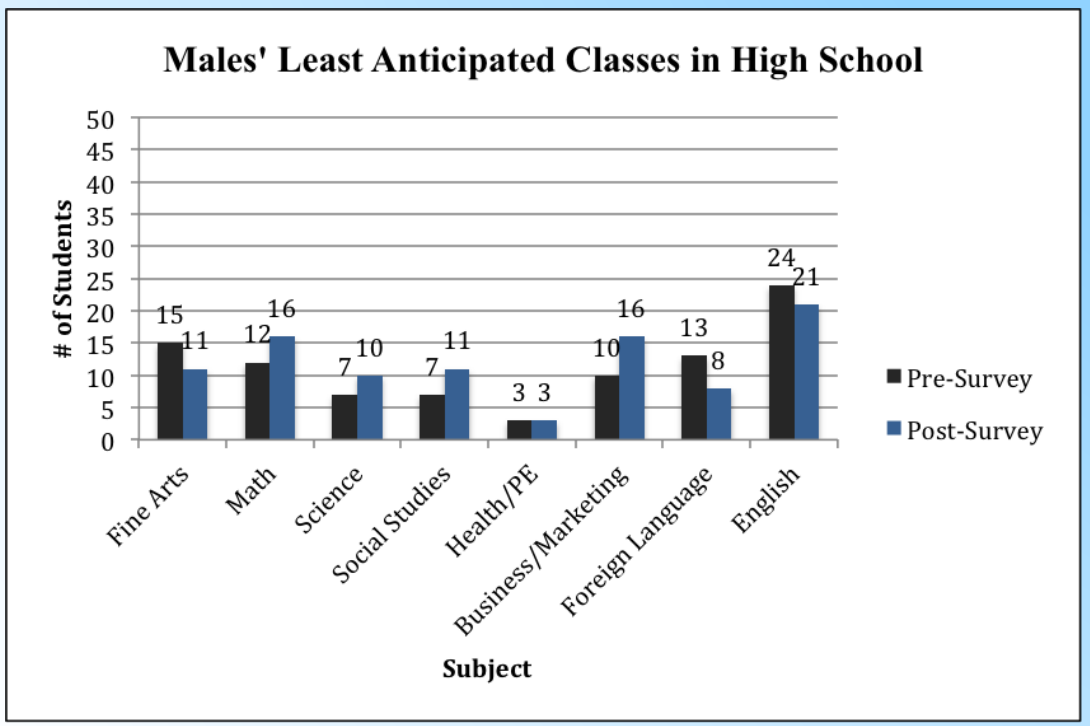
Subject	% Change
Fine Arts	-8.2
Math	57.1
Science	63.6
Social Studies	-25
Health/PE	0
Business/Marketing	-14.3
Foreign Language	-25
English	-33.3



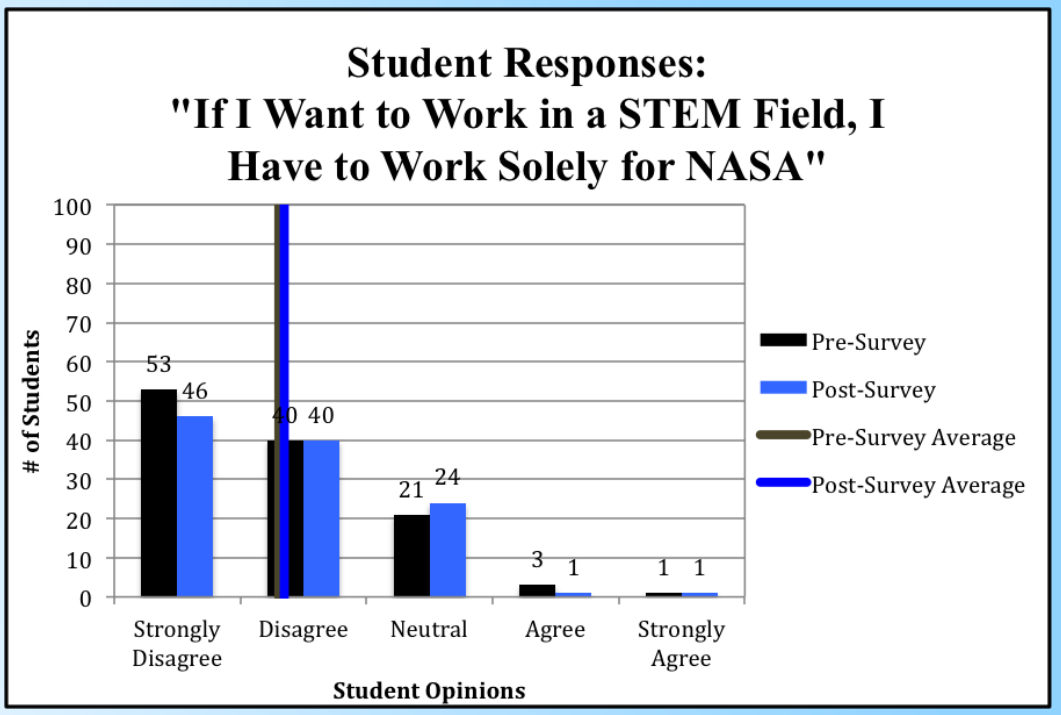
Subject	% Change
Fine Arts	0
Math	0
Science	46.6
Social Studies	0
Health/PE	-4.5
Business/Marketing	-25
Foreign Language	-60
English	100



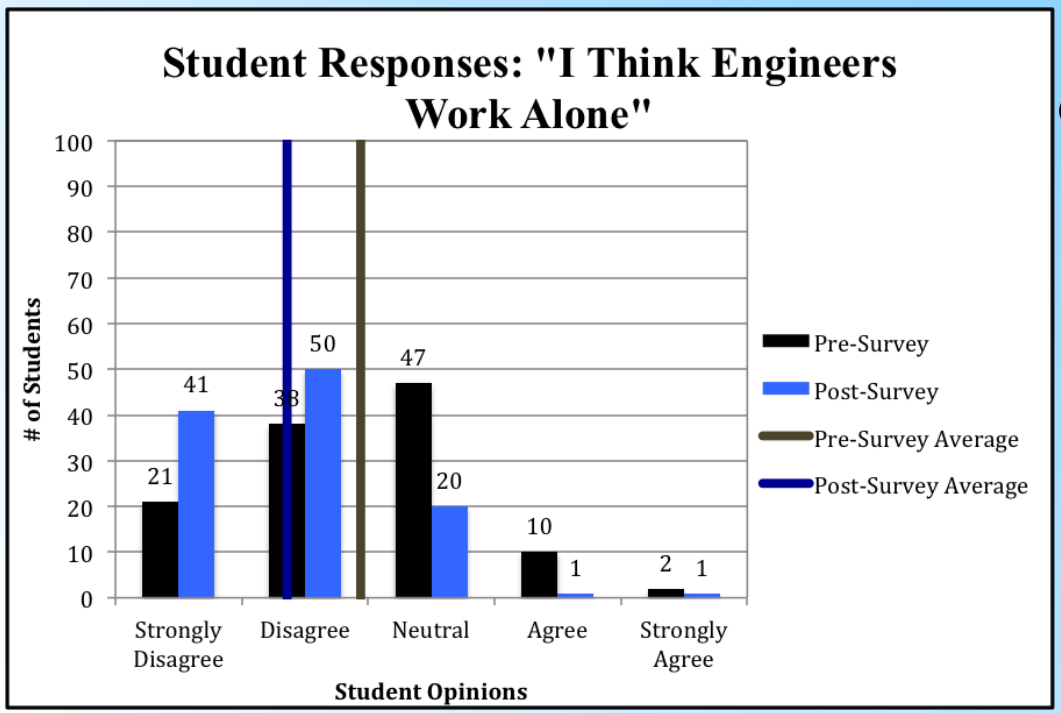
Subject	% Change
Fine Arts	-33.3
Math	3.03
Science	-7.7
Social Studies	-5.26
Health/PE	0
Business/Marketing	0
Foreign Language	-11.11
English	33.33



Subject	% Change
Fine Arts	-36.6
Math	25
Science	30
Social Studies	36.6
Health/PE	0
Business/Marketing	37.5
Foreign Language	-62.5
English	-14.3



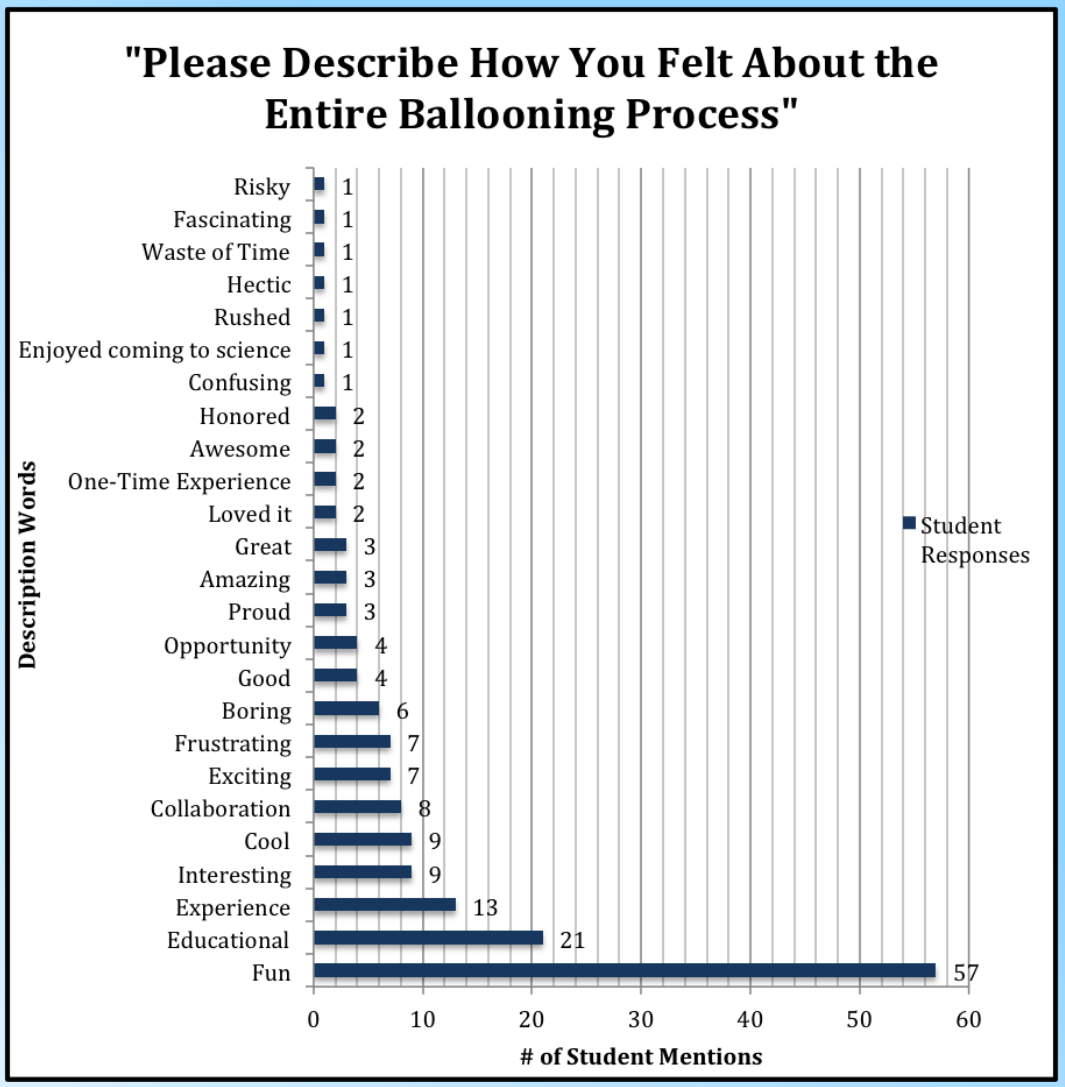
($\bar{X}_1$ = 1.81, n = 118; $\bar{X}_2$= 1.85, n = 112; p = 0.41, α = 0.05)



($\bar{X}_1$= 2.44, n = 118; $\bar{X}_2$= 1.86, n = 113; p = 1.16 x 10^{-6}, α = 0.05)

- 23.9% decrease
- Only survey question displaying significant change

Student Open Responses



Student Open Responses

Considerations for Future Instructors
Have smaller groups (2)
Teachers should **assign roles**
Who holds the payloads when they're launched
End of school so it would be **warm** (2)
Have a little more interaction with the balloon while it's in the air

Bus Chase Considerations
More people go on the bus (7) Two people per team **Everyone** (6)
People voted for someone else for the bus chase (2)

Student Discussions (continued)

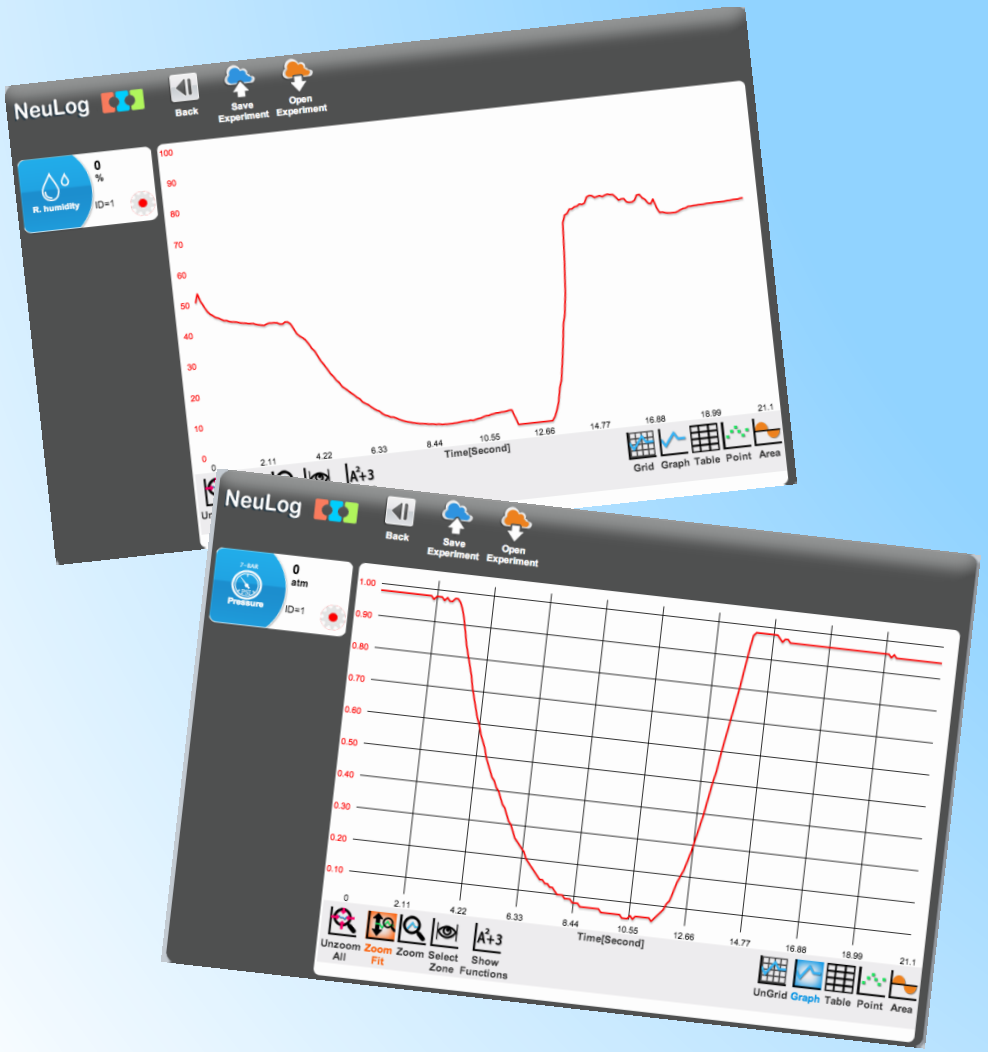
Time Concerns
Longer time in class to design/build payloads (16)
Use your time wisely with construction (6)
Deadlines further away (3)

Future Advice for Other Students and Instructors
Students should be graded on communication
Put kids in the same group where they **all get along** (2)
We would work a lot harder and better together if we got to **pick our own groups** (2)
A lot of people weren't getting their work done (2)
Do your job because some people had to do other peoples' jobs (4)
Nothing (28)

Presentation Day
October 31, 2013

- Assent Forms (Consent forms were previously completed)
- Pre-surveys
- Assigned Project Roles
  - Each team unconsciously appointed a team leader, 8 team leaders were females students

Student Experiments



- Acceleration 1
- Acceleration 2
- UVB
- Humidity
- Temperature
- Wide Range Temperature
- Carbon Dioxide
- Oxygen
- Magnetic Field
- Pressure

- “Space” Banana
- 2 Canon Digital Cameras
- GoPro Video Camera

Design Phase

- Students on the design team worked in class Friday, November 1, 2013 and over the weekend
- Students could create any design to support their assigned data logger
  - Cubes, Pyramids, X-shape, hybrids
- Newman reported that students voluntarily stayed after school to work on their projects!

Construction Phase

- Tuesday, November 5, 2013
- Deadline of Thursday, 4:00 PM
  - Majority of females took lead
  - Education advisor, Dr. Ingwalson impressed

Post Survey

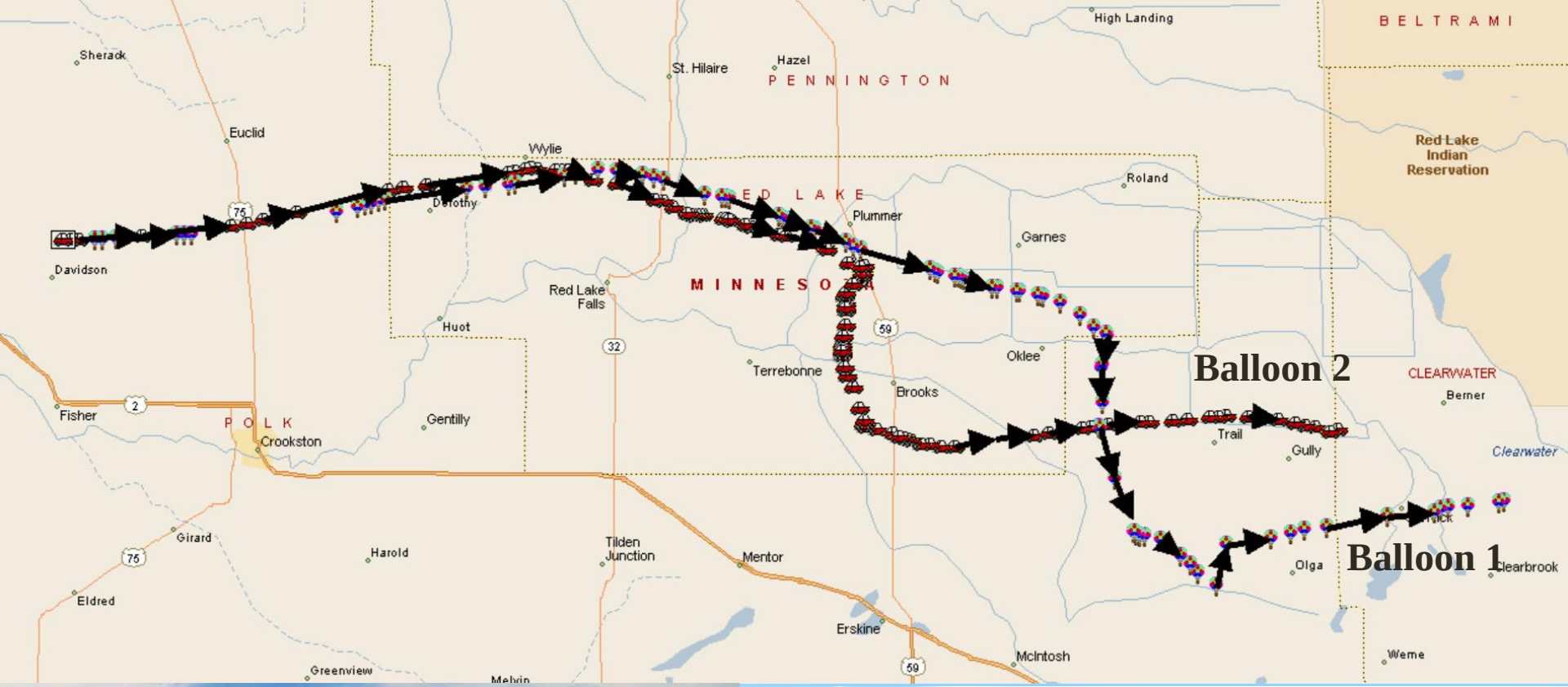
- Students requested more in-class time

Materials

Launch Preparation	Quantity
HARRIS 0-200 PSI Regulator	2
Filling Hose	2
200 ft^3 Helium Tanks	6
Payload Materials	
NeuLog Sensors	10
Banana	2
GoPro Video Camera	1
Canon cameras	2
Balloon Tracking	
1500 gram Kaymont Latex Balloons	2
Kenwood D700 Transceiver	1
Kenwood D710 Transceiver	1
Handheld Kenwood TH- D72A Transceiver	2
SPOT Tracker	2
Microsoft APRS MapPoint	1

Launch Day!

- Wednesday, November 13, 2013
- First time performing a simultaneous launch
- 45 minutes behind schedule, but successful
- 12 students attended the chase, one from each team


Balloon 2
Balloon 1
Sherack
Euclid
Wylie
Hazel
St. Hilaire
PENNINGTON
High Landing
BELTRAMI
Red Lake Indian Reservation
Roland
Plummer
Garnes
RED LAKE
Dorothy
Davidson
Red Lake Falls
MINNESOTA
Huot
Oklee
Terrebonne
Brooks
CLEARWATER
Berner
Trail
Gully
Clearwater
Fisher
POLK
Crookston
Gentilly
Girard
Harold
Tilden Junction
Mentor
Olga
Clearbrook
Eldred
Erskine
McIntosh
Greenview
Melvin
Weme


102,500 ft


102,050 ft

Chase Team

- 4 chase vehicles

- Expressed interest throughout the entire trip
- Received altitude updates from another chase vehicle
- Students learned many technical issues may arise out in the field.
- One male student inquired about studying astronomy

Conclusions

- 3 weeks of this hands-on activity was not effective in influencing students' opinions of STEM.
- Students **enjoyed** and found this balloon project educational
- Students extensively experienced the **engineering method** while working in teams, realizing *engineers do not work alone.*

Outline

- Thesis Statement
- Review of the Literature
- How Does Ballooning Assist This Study?
- Methodology
- Results from this Study
- Ballooning Project Results
- Conclusion
- Future Work
- Acknowledgements

Recommendations for Future Middle School Launches

- Present this activity as an 8th grade "**Capstone" project**; culmination of everything they learned throughout the year
  - Science
  - Math
  - Art and others
- A launch in Spring will be much **warmer** for the students
- Increase in-class work time
- Create additional activities for the students during the filling process
  - Measure the inflated balloon (ideal gas law, ascent rate, size at altitude)

Thesis Documentary Video

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Thank you!