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University Honors Research/Creative Project Approval Form

Submit this form with a hardcopy of your final project. The Honors Office does **NOT** need an electronic copy of this form.

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College: Engineering

Degree: Aerospace Engineering

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Full title of project as it should appear in Graduation Program and on transcript:

Engaging Students in STEM Fields via a Hands-On High Altitude Balloon Project

Abstract (should be included at the beginning of your project as well):

Over the past few years it has become apparent that there is a decrease in the number of students from the United States involved in the areas of Science, Technology, Engineering, and Mathematics (STEM). In order to improve this dilemma and increase the number of students involved in STEM related fields it is critical to mitigate this trend through proactive hands-on projects for young students. The Igniting Young Minds through Space Conference Summary states that in order to "...enhance the STEM learning process, educators should start when students are young" (Richardson). The goal of this UAHuntsville Honors Program Research Project is to review current STEM research efforts, conduct a STEM outreach project at Liberty Middle School in Madison, Alabama, and to write a thesis reporting the results of the research conducted. The objective of this project is to evaluate how a hands-on technical project influences young students' interest in STEM field. The students' interest level in STEM fields and knowledge of high altitude balloons were determined through a quantitative, closed-end survey that was given before and after the implementation of the technical project. Statistical analysis was completed and found a significant difference proving that the students' interest in STEM fields and their knowledge of high altitude balloons increased.

Approved by:

Project Advisor: _____ Date: _____
(Signature)

Department Chair: _____ Date: _____
(Signature)

Honors Program Director: _____ Date: _____ (Signature)

Engaging Students in STEM Fields via a Hands-On High Altitude Balloon Project

Jennifer Hunt

H 499: Honor's Thesis

6-14-2011

Abstract

Over the past few years it has become apparent that there is a decrease in the number of students from the United States involved in the areas of Science, Technology, Engineering, and Mathematics (STEM). In order to improve this dilemma and increase the number of students involved in STEM related fields it is critical to mitigate this trend through proactive hands-on projects for young students. The Igniting Young Minds through Space Conference Summary states that in order to "...enhance the STEM learning process, educators should start when students are young" (Richardson). The goal of this UAHuntsville Honors Program Research Project is to review current STEM research efforts, conduct a STEM outreach project at Liberty Middle School in Madison, Alabama, and to write a thesis reporting the results of the research conducted. The objective of this project is to evaluate how a hands-on technical project influences young students' interest in STEM field. The students' interest level in STEM fields and knowledge of high altitude balloons were determined through a quantitative, closed-end survey that was given before and after the implementation of the technical project. Statistical analysis was completed and found a significant difference proving that the students' interest in STEM fields and their knowledge of high altitude balloons increased.

Introduction

The goal of this UAHuntsville Honors Program Research Project is to review current STEM research efforts and to conduct a STEM outreach project at Liberty Middle School, in Madison, Alabama, in order to evaluate how a hands-on technical project influences young students' interest in STEM fields. The hands-on technical project revolved around high altitude sounding balloon experiments. The project student mentors, four students from the UAHuntsville Space Hardware Club, lead the students through brainstorming experiments, designing the experiment, and fabricating the experimental payload. The student mentors then launched the high altitude from Liberty Middle School's baseball diamond in front of approximately seven hundred 7th and 8th grade students.

In order to measure a students' interest level in STEM fields a quantitative, closed-end survey was given before and after the implementation of the technical project. Statistical analysis was completed in order to gauge if the technical project had a significant effect on the students' interest in STEM fields or their knowledge of high altitude sounding balloons.

Literature Review

Possibly the most challenging aspect of this project was to try to fully develop an effective hands-on project. "To effectively teach engineering, one must first develop a toolset for the students to use that allows them to build and design freely, easily, and with the greatest functionality" (Rogers). However, Rogers also cautioned that "[i]t is important that the students do not get hung up with the tools and lose sight of the engineering or the science." This advice helped the formation of the hands-on high altitude balloon flight project.

Savage states that the key elements of project based learning (PBL) activities include:

- 1) Establishing team dynamics and the role of the instructor
- 2) Identifying the design problem and having students develop enough background knowledge to understand the application
- 3) Detailing the parameters necessary to solve the problem
- 4) Encouraging the students to brainstorm with their teammates
- 5) Fabricating a prototype of the design solution
- 6) Summarizing the results in both written and oral reports.

The key elements of PBL described by Savage were also used when designing the hands-on high altitude balloon experiment for the middle school students, which can be observed in the Methods Used to Perform the Project section. “A project, based on solving a technical design problem, gives students a contextual environment that makes learning relevant and focused. Solving the problem drives learning, rather than the traditional “tech by telling” lecture format.” (Savage). The fact that learning is further absorbed in this fashion indicates that a hands-on project might actually permanently affect a student’s knowledge and perhaps even their view of STEM fields.

Methods Used

In order to measure a students’ interest level in STEM fields a quantitative, closed-end survey was given before and after the implementation of the technical project. The technical project consisted of a lecture, a brainstorming session, experiment design, payload fabrication, and launch of the balloon and experimental payloads. After the technical project intervention was completed, statistical analysis was performed in order to gauge if the project had a significant effect on the students’ interest in STEM fields or their knowledge of high altitude sounding balloons.

1. Initial Survey – February 16th, 2011

An initial twelve statement Likert scale (1-5) survey was given to the students before the project was even introduced to them. A copy of the survey is provided in the Appendix. Statements 2, 4, and 7 were eliminated after the survey because they were deemed not relevant based on the dependent variables, interest in STEM fields and knowledge of high altitude sounding balloons, being analyzed. A copy of the survey is provided in the Appendix.

2. Lecture – February 16th, 2011

An introduction to high altitude sounding balloons lecture was given to the students by the student mentors in order to give them some background knowledge about the hands-on technical project which they were going to be asked to complete. To put their knowledge into perspective, these students are just learning algebra. The lecture covered the physical properties of the high altitude sounding balloon, the property of buoyancy, the variance of temperature, pressure, and density with respect to altitude, and the ideal gas law. Once these students were able to understand the environment in which the experiment would take place they could begin to brainstorm relevant experiment ideas.

3. Brainstorming – March 2nd, 2011

The class of students was split into four experiment groups. These groups, each with a student mentor, brainstormed possible experiment ideas for the

environment a high altitude sounding balloon would experience. The mentors reminded them of the environment and helped guide their discussion; however, the chosen experiments were thought of and picked solely by the student groups.

4. Experiment Design – March 2nd, 2011

Once brainstorming was complete the students selected which experiments they wanted to complete. The design of the experiments needed to be completed. The design process included discussing what was needed in order to complete the experiment like data loggers, mounting fixtures, cameras, etc. The design of the individual experiments was important so that the student mentors knew what needed to be brought during the next meeting which consisted on constructing the payloads.

5. Payload Fabrication - March 30th, 2011

Once the experiment design was completed and the materials needed to complete the payloads were acquired the payloads could be constructed. The students used all sorts of materials to construct their payload which could then be attached to the payload line via parachute chord. The images below display the four individual student groups working with their student mentors in order to fabricate their experimental payloads.



6. Balloon Launch – April 13th, 2011

The student mentors returned to the middle school to launch experiments the students fabricated attached to the balloon. The balloon was filled on the middle school's baseball diamond and the entire seventh and eighth grade classes came out and watched the launch. The following images are of the balloon launch.





7. Follow-Up Survey – April 20th, 2011

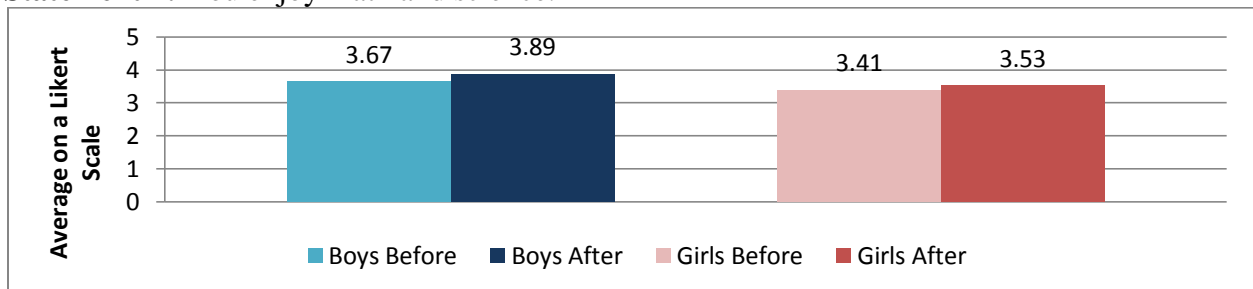
After the balloon was recovered and the experimental results interrupted the student mentors returned to the middle school. The mentors presented the outcomes of the experiments to the students. Finally, after the entire hands-on project was completed, the follow-up survey was filled out by the students.

Results

The initial survey and follow-up survey results were tabulated and analyzed. The average response of the boys and girls were found for each statement for both the initial and follow-up surveys. A chi-square analysis was completed, with a 95% confidence level, in order to find if there was a significant change in the student’s attitudes towards STEM fields or in their knowledge of high altitude sounding balloons.

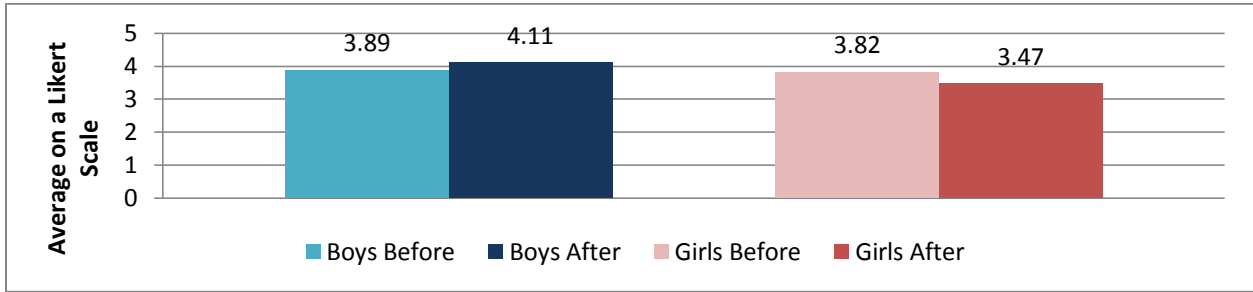
The class consisted of a sample of 9 boys (nb) and 17 girls (ng). Based on the number of boys and girls a critical Chi Square value can be found using a confidence level of 95%. The critical Chi Square value for the boys is 15.51 and the critical Chi Square value for the girls is 26.3. If the Chi Square value found is greater than the critical Chi Square value then this proves that there is a significant difference between the students’ survey responses before and after the hands-on balloon project took place.

Statement 1: You enjoy math and science.



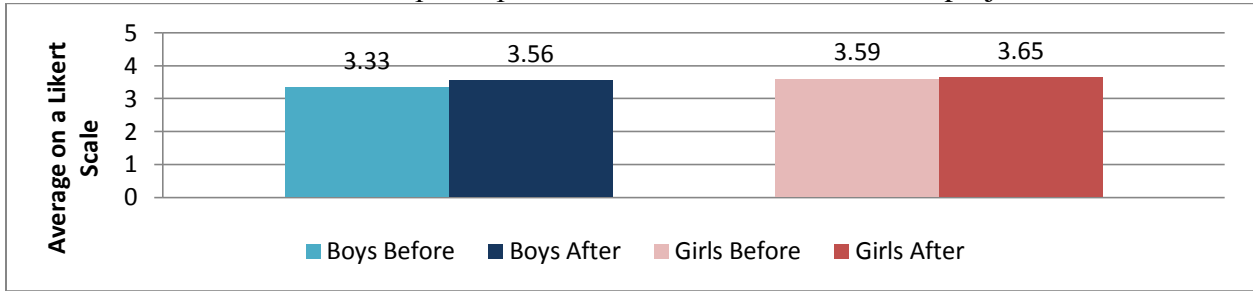
nb=9, ng=17, a=0.05, chi-square boy = 7.5, chi-square girl = 5.07

Statement 3: Your math and science classes are fun.



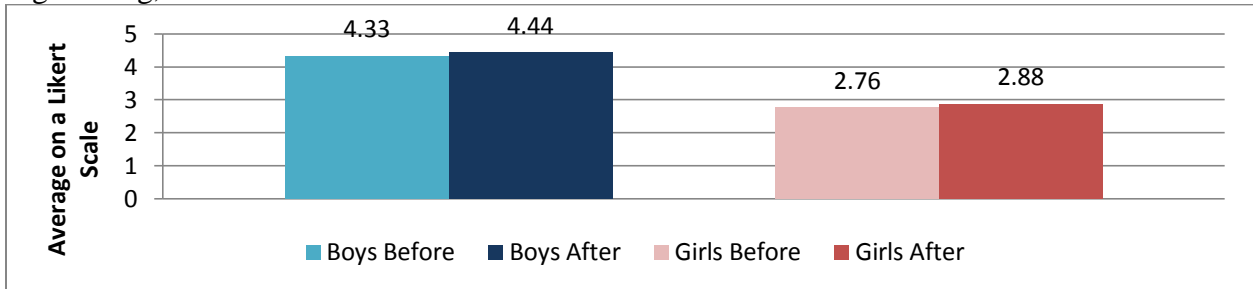
nb=9, ng=17, chi-square boy = 2.42, chi-square girl = 7.42

Statement 5: You're excited to participate in math and science hands-on projects.



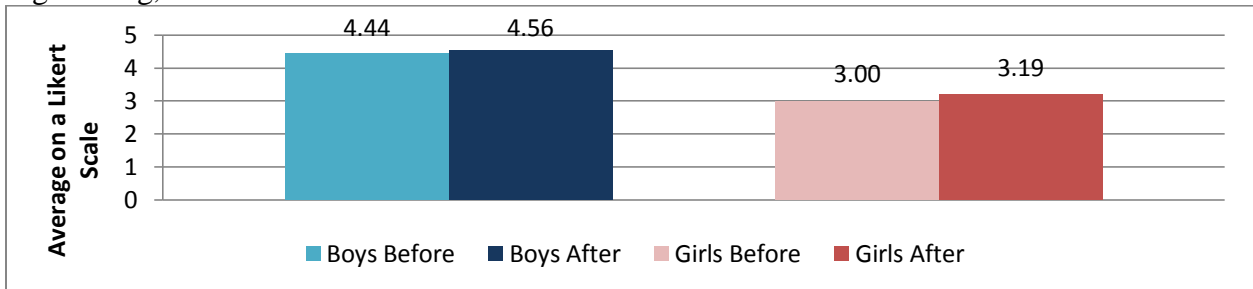
nb=9, ng=17, chi-square boy = 24.33, chi-square girl = 8.33

Statement 6: You're interested in pursuing a career related to the fields of science, technology, engineering, and math.



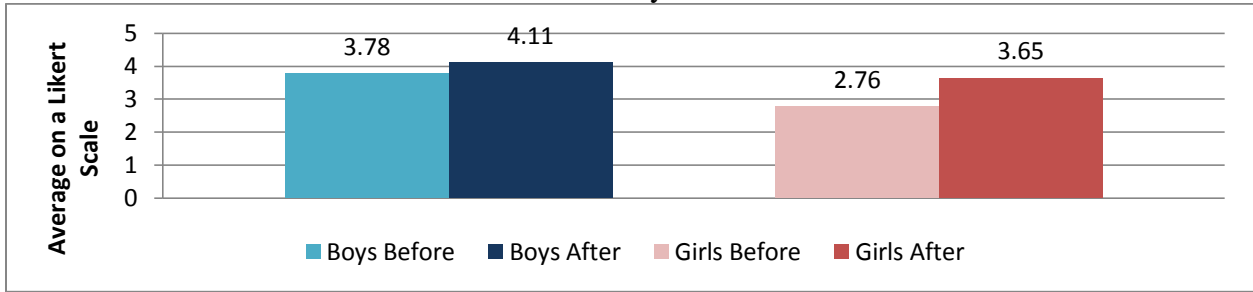
nb=9, ng=17, chi-square boy = 17, chi-square girl = 15.17

Statement 8: You're interested in pursuing a college degree related to science, technology, engineering, or math.



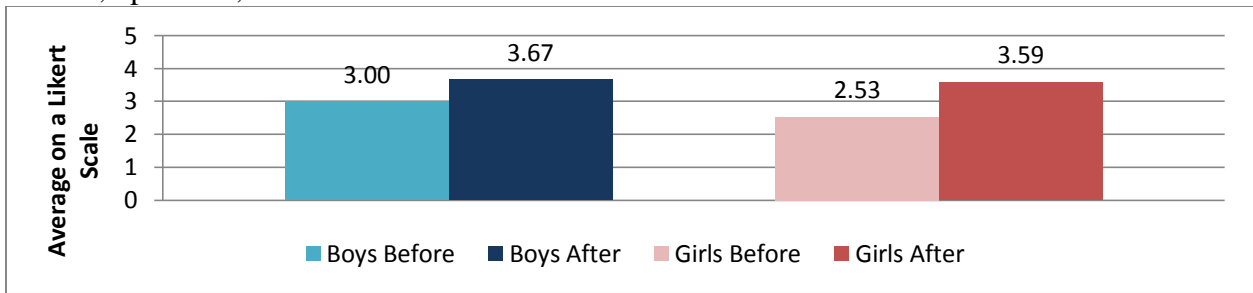
nb=9, ng=17, chi-square boy = 2.33, chi-square girl = 7.22

Statement 9: You know a lot about how air density varies with altitude.



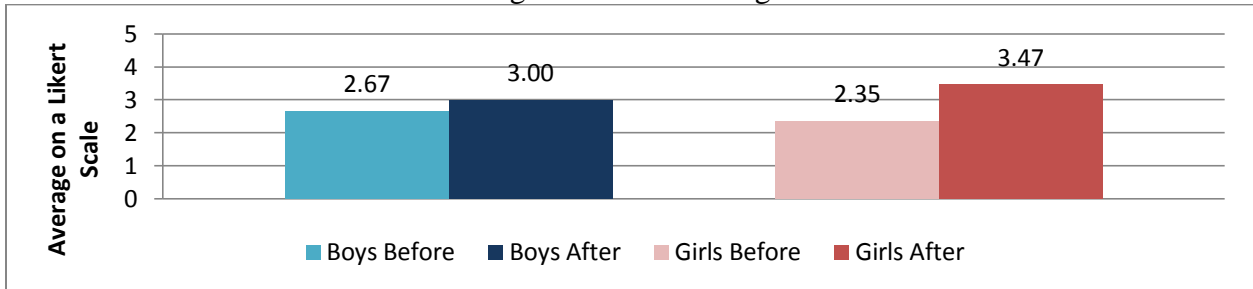
nb=9, ng=17, chi-square boy = 18.75, chi-square girl = 99.31

Statement 10: You know a lot about how atmosphere temperature and pressure varies with altitude, up to 100,000 feet.



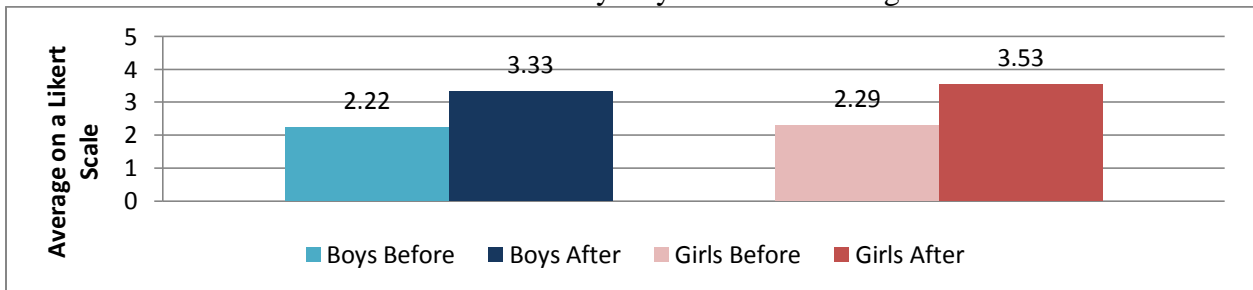
nb=9, nb=17, chi-square boy = 24, chi-square girl = 26.89

Statement 11: You know a lot about high altitude sounding balloons.



nb=9, ng=17, chi-square boy = 4.9, chi-square girl = 219.8

Statement 12: You know a lot about how buoyancy is related to a high altitude balloon.



nb=9, ng=17, chi-square boy = 10.5, chi-square girl = 139.8

Discussion

The results to statements 5, 6, 9, 10, 11, and 12 showed a statically significant change in the students' interest in STEM fields or their knowledge of high altitude sounding balloons. Statements 5 and 6 are related to the students' interest in STEM fields. Statements 9, 10, 11, and 12 are related to the students' knowledge of high altitude sounding balloons.

Interest Level in STEM Fields:

Statement 5, "You're excited to participate in math and science hands-on projects" had a chi-square value of 24.33 for the boys. Therefore, the hands-on high altitude balloon launch had a 95% confident statistically significant affect on the boys' excitement to participate in math and science hands-on projects.

Statement 6, "You're interested in pursuing a career related to the fields of science, technology, engineering, and math" had a chi-square value of 17 for the boys. Therefore, the hands-on high altitude balloon launch had a 95% confident statistically significant affect on the boys' interest in pursuing a career related to the fields of science, technology, engineering, and math.

Knowledge of High Altitude Balloons:

Statement 9, "You know a lot about how air density varies with altitude" had a chi-square value of 18.75 for the boys and a chi-square value of 99.31 for the girls. Therefore, the hands-on high altitude balloon launch had a 95% confident statistically significant affect on how much the boys and girls believe they know of how air density varies with altitude.

Statement 10, "You know a lot about how atmosphere temperature and pressure varies with altitude, up to 100,000 feet" had a chi-square value of 24 for the boys and a chi-square value of 26.89 for the girls. Therefore, the hands-on high altitude balloon launch had a 95% confident statistically significant affect on how much the boys and girls believe they know of how the atmosphere temperature and pressure varies with altitude, up to 100,000 feet.

Statement 11, "You know a lot about high altitude sounding balloons" had a chi-square value of 219.8 for the girls. Therefore, the hands-on high altitude balloon launch had a 95% confident statistically significant affect on how much the girls believe they know of high altitude sounding balloons.

Statement 12, "You know a lot about how buoyancy is related to a high altitude balloon" had a chi-square value of 139.8 for the girls. Therefore, the hands-on high altitude balloon launch had a 95% confident statistically significant affect on how much the girls believe they know of how buoyancy is related to a high altitude balloon.

Conclusions

The goal of this UAHuntsville Honors Program Research Project was to review current STEM research efforts and to conduct a STEM outreach project at Liberty Middle School, in Madison, Alabama, in order to evaluate how a hands-on technical project influences young students' interest in STEM fields. Based on the results of the surveys there were 95% confident significant differences in the students' interest in STEM fields and their knowledge of high altitude sounding balloons.

Because there were significant differences in the students' responses it can be concluded that the hands-on high altitude balloon project was an effective project to increase a students'

interest in STEM fields and their knowledge of high altitude sounding balloons. The fact that this goal was met is very significant to STEM fields.

Acknowledgements

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Mr. Bill Brown

Works Cited

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Rogers, Chris, and Merredith Portsmore. "Bringing Engineering to Elementary School." *Journal of STEM Education* 5.3 & 4 (2004): 17-28. *Journal of STEM Education*. Web.

<[http://ojs.jstem.org/index.php?journal=JSTEM&page=article&op=view&path\[\]=1126&path\[\]=981](http://ojs.jstem.org/index.php?journal=JSTEM&page=article&op=view&path[]=1126&path[]=981)>.

Savage, Richard N., Katherine C. Chen, and Linda Vanasupa. "Integrating Project-based Learning throughout the Undergraduate Engineering Curriculum." *Journal of STEM Education* 8.3 & 4 (2007): 15-27. *Journal of STEM Education*. Web.

<[http://ojs.jstem.org/index.php?journal=JSTEM&page=article&op=view&path\[\]=1387&path\[\]=1194](http://ojs.jstem.org/index.php?journal=JSTEM&page=article&op=view&path[]=1387&path[]=1194)>.

Appendix

Number: _____

Date: _____

Please circle an answer that fits best the response to each statement:

1-Strongly Disagree 2-Disagree 3-Neither Agree nor Disagree 4-Agree 5-Strongly Agree

Questions:

You enjoy math and science. **1 2 3 4 5**

Your math and science classes are hands-on. **1 2 3 4 5**

Your math and science classes are fun. **1 2 3 4 5**

You enjoyed participating in science fair. (Do **NOT** answer if you did not participate) **1 2 3 4 5**

You're excited to participate in math and science hands-on projects. **1 2 3 4 5**

You're interested in pursuing a career related to the fields of science, technology, engineering, and math. **1 2 3 4 5**

You're interested in pursuing a college degree. **1 2 3 4 5**

You're interested in pursuing a college degree related to science, technology, engineering, or math. **1 2 3 4 5**

You know a lot about how air density varies with altitude. **1 2 3 4 5**

You know a lot about how atmosphere temperature and pressure varies with altitude, up to 100,000 feet. **1 2 3 4 5**

You know a lot about high altitude sounding balloons. **1 2 3 4 5**

You know a lot about how buoyancy is related to a high altitude balloon. **1 2 3 4 5**

Other Questions:

Age: _____

Circle one answer for each of the following:

Gender: Female Male

Ethnicity:

American Indian or Alaska Native

Asian

Black or African American

Native Hawaiian or Other Pacific Islander

White/Caucasian

Hispanic or Latino