Improved Methods for Teaching Science

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Get Away Special Microgravity Research Team

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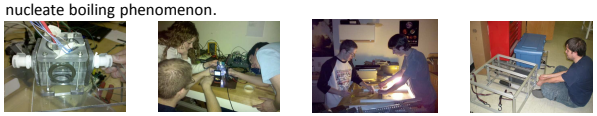
Introduction

Utah State University's Get Away Special (GAS) team will conduct research aboard NASA's microgravity research aircraft, the "vomit comet," through the Reduced Gravity Student Flight Opportunities program. Team members come from mechanical and aerospace engineering, computer science, physics, science education, and business backgrounds. The team will spend ten days this summer at NASA's Johnson Space Center and perform experiments on the aircraft to better understand nucleate boiling, a potential method of efficient heat transfer in space.

FUNBOE (Follow-Up Nucleate Boiling On-flight Experiment)

As we strive for the development and exploration of space, thermal management systems must be designed to be robust, efficient, and effective in the harshest of environments. Nucleate boiling is a well-known and heavily researched mode of boiling. It would be ideal for thermal management systems because of its high heat transfer rates. Nucleate boiling in space is heavily dependent on characteristics such as working fluid, sub cooling, heat flux, and surface geometry. The assumptions of one system do not give immediate understanding to all systems. Many experiments have been performed to study nucleate boiling in microgravity using thin-wire heating elements. The incompatibly of these experimental results have prevented a true understanding of this complex phenomenon.

The FUNBOE experiment is designed to better understand nucleate boiling in microgravity and how different characteristics impact its behavior. It has been selected to be one of fourteen university experiments to fly on NASA's vomit comet in June 2010. Bubble formation and motion are recorded with cameras as bubbles leave wires acting as resistive heating elements. A computer data acquisition system also records the wire temperature, current, and voltage. This data will be later analyzed and will add to the understanding of the nucleate boiling phenomenon.



Goals

Why do we do research and outreach? Because it is fun and we enjoy teaching others about science! The GAS team promotes and provides outreach opportunities to other students as a means to help them understand the need for constant experimentation. This can be motivation for them, as well as for ourselves, that no matter what, not even the sky can limit you.

The goals and purposes of the outreach program include:

- To help young children gain interest in the sciences.
- To motivate students to study science.
- To aid students in their goals for a better life.
- To help the students consider STEM opportunities.
- To promote others to gain a higher education and to see the benefits.
- To provide a positive example and motivation of others who are currently gaining higher education.

Methods

As part of the FUNBOE research, an ambitious science, technology, engineering, and mathematics (STEM) outreach program was organized.

- Twenty-four local elementary schools were contacted for science lesson presentations.
- Grade specific curriculum criteria, set by the state for the teachers, were used in planning the lesson plans.
- Use of principles prominent in our GAS research was a primary selection criterion for presentation topics.
- Topics selected included heat transfer, states of matter, and methods of producing heat.
- Demonstrations exhibiting these scientific principles were developed.
- The presentation emphasized a variety of inquiry-based experiences in which students were able to interact with us, participate directly in hands-on experiments, and hypothesize their own potential outcome.

In the third grade lesson plan we teach the students about changes in the states of matter. This relates to our research when the water changes states from liquid to a gas as it boils. Two demonstration experiments that were useful in solidifying the concepts to the students were the dancing cornstarch and the gas balloon.

On one occasion students were not allowed to touch the dancing cornstarch after the demonstration. We observed a notable decrease in the comprehension of the less "hands-on" group, indicating the importance of tactile learning. After we taught the differences between solids, liquids, and gases, we explained how they change physically and chemically. During the presentation of the gas balloon, the students were able to observe, and later explain, what states of matter the substances were in. As the substances were mixed together the students perceived how they changed physically and chemically. This example is effective because the students examine the changes simultaneously.

The lesson plans used are available on the team website, www.gas.physics.usu.edu, for review and use.

Lessons have been taught in eight 2nd, 3rd, 5th, and 6th grade classrooms across Cache Valley as well as the Whittier Center and the Clark Planetarium.

Conclusions

Following each school visit, we analyzed individ demonstration outcomes and teachers also completed surve Based on our results, changes were incorporated wh increased the effectiveness of our teaching methods.

- We concluded that teaching classes of smaller sizes increases student involvement. This also increases the likelihood of a more enriching and enjoyab learning atmosphere.
- In preparing for a demonstration, it is crucial to practice each experiment to avo unforeseen errors and ensure correct experiment duration and outcomes.
- The practice of immediately following presentations with hands-on experiences allows the students to touch and feel the experiments. This helps them solidify the scientific principles being taught. It also allows the presenters more individ time with the students to answer questions and provide further explanation.
- Thoroughly planned and thought out demonstrations help students comprehen multiple scientific concepts using one experiment.

Based on the feedback given from the teachers we learned :

- Hands-on activities involving all students proved to be more enjoyable and increased their learning comprehension.
- Science resources for elementary students are extremely limited. "We rarely ha science books in elementary schools…To see science in action and see how (students) are able to apply what they learn is wonderful!"
- Teaching the students science increased their knowledge and interest. "The students loved the things you brought to show science in action."

Further Work

Outreach is a never ending adventure. There are always young mind different stages of learning and educational development to reach. We plan on teaching and being role models as we present the results of our experiment and experience with NASA next fall. New lesson plans will be created for the varying grade levels that we teach. The next major step is to interact with middle schools and high schools. We have a goal of reaching over 2000 students next year (more than double our current influence).

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