BalloonSats: One key to better math, science, and technology knowledge

Slide 1

In this presentation, I want to convince you to help young students develop better math, science, and technology skills. America needs those skills if it's to retain its strength and competitive advantage in the future. One way you can help is using BalloonSats, a really neat first step to outer space.

Slide 2

Near space looks and feels like outer space. So students who make a BalloonSat will feel they're designing a real satellite. This is motivating for students with a space interest, which is most kids before they enter high school. And as a result, their interest in math, science, and technology is rewarded and perhaps even encouraged as a future college major and career.

The reason to use BalloonSats is that they're faster, cheaper, and easier to make than a satellite or even complete near spacecraft. That's because BalloonSats don't need tracking equipment, it's already provided for them. Therefore, students don't need to earn a radio license before building a BalloonSat. Students only need to focus on their energies on designing and building a large but lightweight airframe and on analyzing their data.

Slide 3

Hold up a basic BalloonSat and Hobo

BalloonSats are easy to build because they're essentially a Styrofoam box. The sides are glued together with hot glue and the airframe covered in tape. The avionics typically consists of a Hobo datalogger with internal temperature sensor, an external temperature sensor, an APS camera, a 555-based timer that operates the camera every three to four minutes, and some kind of passive experiment.

Pass around BalloonSat and Hobo

Slide 4

Making a BalloonSat doesn't take very long and you don't need to be there for the entire time. As a volunteer, you only need to help guide the students in their construction, testing, flight, and data analysis. In the workshop setting, student teams can assemble a BalloonSat in two days, that is, if they have half a day available on each day.

In a classroom setting, BalloonSats are combined with other class work and it takes closer to two weeks to complete one.

In either setting, teams should be limited to a maximum of four students or you end up with bored students who are going to look for other things to do. And some of those unwanted activities may involve the hot glue gun or rubber bands.

Slide 5

Kids can get pretty busy making their BalloonSat. First, they have to plan a BalloonSat design and lay it out on Styrofoam.

Then there's the actual test fitting and construction. This is frequently followed by modification, since many students have never built a BalloonSat before nor have the patience to carefully design the airframe. Apparently, schools and families don't teach the measure twice, cut once rule anymore.

After the construction of their BalloonSat, there's the programming of the avionics. Here students become familiar with telling the datalogger how often to collect data and from which sensors.

Then there's the testing, or as I like to call it, the torture of the BalloonSat.

One test is the thermal test to see how cold the interior of the BalloonSat can get and how fast. BalloonSats should retain heat as long as possible unless Frosty the Snowman is a passenger.

Then there's a drop test to verify that the BalloonSat will remain in one piece during landing.

Some teams perform a shake test that proves the BalloonSat will properly hold its guts together during its mission.

Finally, there's a function test that does two things. First, it ensures the crew can quickly get their BalloonSat ready at the launch site. After all, you don't want teens struggling to closeout their BalloonSat after filling the balloon. The other half of the function test checks that the BalloonSat will work as designed. The most comprehensive test uses a roll of camera film and runs the BalloonSat for three hours. Needless to say, you don't often see a full up test of the BalloonSat. Still, the function test lets students debug their BalloonSat design.

I have yet to see a BalloonSat fail these tests, except perhaps for thermal testing because I have seen cameras quit working during a flight.

Slide 6

Hold up and pass around a BalloonSat containing flight computer

Students who have flown before, or are ready for a more sophisticated challenge, can substitute a simple programmable flight computer in place of the Hobo datalogger. I've designed one specifically for BalloonSats that collects data like a Hobo, but operates experiments, unlike a Hobo datalogger.

Hold up and pass around a PICAXE intervalometer

If an intervalometer operates an onboard camera, then advanced students can assemble a PICAXE based intervalometer and learn to program it.

Finally, experienced students can add a digital camera to their BalloonSat in place of an APS camera. The digital camera will allow the students to record more pictures during the mission. Be aware however that some digital cameras shut themselves off if they're not used within 30 or 60 seconds. This is where a flight computer and programmable intervalometer shines, because they have better control the camera than a 555 timer-based intervalometer.

Slide 7

After recovery, there's data to download and analyze. With Hobo data loggers, students will discover how cold their BalloonSats get during its near space mission.

Hold up and pass around chart of air temperature and humidity

However, if you'll help students incorporate APRS data into their spreadsheet then they can convert time into altitude and discover where the stratosphere begins or how the relative humidity changes as a function of altitude.

Hold up and pass around a chart of wind speed

Even having just APRS data is useful. With it, students can determine the wind's speed as a function of altitude. They can discover the existence of the jet stream.

Slide 8

I'd be lying if I told you there were no potential problems you could run into, so I would like to briefly discuss them.

First, there's the issue of weather. BalloonSat classes are scheduled in advance for particular days and are therefore hostage to the weather. If the weather won't let a launch occur on the scheduled day, then the students will have built their BalloonSat for nothing. So have a backup launch day in case of bad weather.

Hot glue guns can burn and Exacto knives can cut. This is a greater risk with younger students. While schools and unions can protect most teachers from simple accidents during class time, you may not be protected when helping a class as a volunteer. So

check with the host organization, make them aware of the risk, see that the kids are using safety equipment, and watch everyone like a hawk.

Regrettably, there will be some students who are simply not interested. In the classroom, there is often an appropriate activity for these students. That way they're out of trouble and not leading other students off-task. It's a bit easier for workshops since students shouldn't be there if they're not interested in BalloonSats in the first place. However, you can still find students who were signed up by their parents without student involvement.

A BalloonSats launch needs a launch and chase crew. Since many classes take place during work days, it can be difficult to line up working adults for the chase and recovery crews when the launch takes place on a Wednesday morning. Therefore, it's a good idea to have your own amateur radio license and tracking equipment. And don't forget that you'll increase your odds of success if there's more than one mobile tracker. So let any potential help know about the launch weeks in advance and don't forget to involve retirees.

A second liability issue is students going on chase. If a driver is not a bus driver, then accidents are probably not covered by the school. Irate parents can unfairly shut down a BalloonSat program if their child is injured during a chase.

But don't let these risks prevent you from participating in a BalloonSat class. The benefits far outweigh the risks and the risks can be mitigated. Just be aware that there are risks and that you need to stay on top of them.

Slide 9

There's a lot of exciting activity on launch day. So try to involve the students with prep, launch, chase, and recovery of their BalloonSat. If they can't however, then have them track the flight over Findu.com. There they can act as mission control and with the help of a licensed ham, even communicate with the chase crew.

Slide 10

I'm helping to advance BalloonSats by putting my thoughts and experiences into a series of articles and a book. In the Society of Amateur Scientists' newsletter, The Citizen Scientist, you'll find my monthly how-to column for the BalloonSat. So far, the column has covered BalloonSat construction and experiments. And before the end of the year, the column will begin addressing issues of data processing. Next year the articles will be expanded and published in a book tentatively called the BalloonSat Principia.

Hold up and pass chapters around

The BalloonSat Principia will thoroughly explain BalloonSat construction, describe dataloggers, their data formatting, step by step data analysis, discuss using ping pong balls as airframes, show you how to build and program two simple flight computers, and help students build several types of experiments. Version 1 copies of the first five chapters and one appendix are available for you to look at right now.

Slide 11

If you have experience launching near spacecraft, then I encourage you to get help out at a BalloonSat class, or even start one yourself. Your participation could turn a kid from drifting with the current to actively pursuing a math, science, and technology career and education.

Feel free to contact me for or with ideas. You'll find some of my thoughts in Nuts and Volts magazine, ATV Quarterly, and The Citizen Scientist.

Are there any questions or comments?