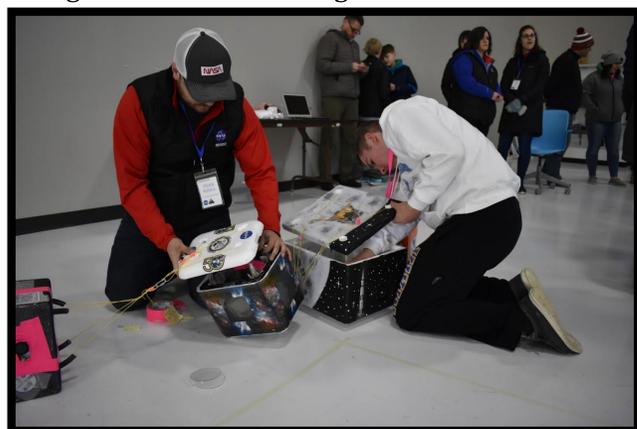


## Abstract

Science, Technology, Engineering, and Math (STEM) are an integral part of a modern K-12 education curriculum. As such, students should be exposed to, and engage in, STEM related activities that induce excitement. High-altitude ballooning provides a cost effective, interactive, fun, creative, and safe project that students across the country could engage in. The Near-Space Balloon Challenge (NSBC), supported by the North Dakota Space Grant Consortium (NDSGC), is an annual semester long event in which middle and high school age students across the state of North Dakota participate in a STEM related project pertaining to high-altitude ballooning. The challenge implements aspects of the scientific method, engineering design, mission preparedness, creativity, and overall teamwork. It requires the students to develop a scientific hypothesis about the tiers of the atmosphere, design and build a payload to test that hypothesis, and analyze the data that was collected. All of which culminate to the excitement of launching a large balloon to the edge of space. Projects can be in any STEM related topic, allowing the students to be creative. Past experiments have ranged from ozone detection, plant survivability, to microbes in the atmosphere. Through the success of this endeavor, the NDSGC provides the framework for other institutions to implement similar projects for STEM engagement in K-12 education related to high-altitude ballooning.



Ballooning team member and Student preparing payloads for launch during the 2019 NSBC.

## Framework

- NSBC is a semester long process.
- Start by gauging interest – “The Call”. This helps determine which schools are interested in participating.
- Request Proposals from interested schools. After all proposals are received, they are reviewed for selection to participate.
- If a school is selected, they are connected with a “mentor”. Mentors are typically graduate student volunteers with varying backgrounds of expertise. The mentors are there to guide students during the payload development phase.
- From then until the event, students and their mentors develop and design a scientific payload.
- Their payload and proposal have to meet a certain criteria that incorporate scientific inquiry and engineering design.



Image from “Near-Space” on balloon 2 of the 2019 NSBC.

## The Event

Separated into two days – “Integration Night” and Launch Day

### Integration Night

- Integration night is separated into three main sections – welcome ceremony, presentations, and a workshop.
- The welcome ceremony welcomes students to the event, have a meet & greet with their mentor, and go over an itinerary for the two-day event.
- The presentation portion has students present their payload to the rest of participants.
- The workshop portion allows students to make any final adjustments to their payload. This also allows them to ask questions to the ballooning team or other students, fostering a collaborative environment.
- At the end of the night, all of the payloads are strung together and prepared for flight.



Launch of balloon #1 during the 2019 NSBC.

### Launch Day

- Launch day is separated into four sections – the launch, tracking, STEM activities, and payload retrieval.
- The launch occurs early the day after integration night (weather permitting). A representative from each school is allowed to hold their payload before it is launched.
- During tracking, students follow the balloon on its trajectory. They make estimates on the burst altitude.
- After burst, students wait for retrieval. During this time, they are a variety of STEM activities available to them (i.e., tours, VR experiences, etc.).
- Also during this time, an award ceremony is held to commemorate all of the hard work done by the students. Awards are decided by their peers and the ballooning team.
- A recovery team is sent to track and follow the balloon and attempt retrieval. Participants are permitted to wait for their return, or they can have their payload mailed to them.

### Post Event

- After the retrieval, the payloads are sent back to the schools for analysis.
- Students are expected to analyze the data collected and compile a Final Report.
- Their final report is then evaluated by the event organizers.
- This evaluation aids in determining the top three participating schools.

## 2019 NSBC

- This was the 9<sup>th</sup> annual NSBC
- Organized by the North Dakota Space Grant Consortium and hosted by the University of North Dakota (UND).
- 9 participating schools from across North Dakota, with nearly 100 attendees.
- Payloads topics varied, some of which included microbes in the atmosphere, tomato seeds, adult plants, various fluids, solar panels, and many more.
- 2 Kaymont 2000 balloons affixed with 12lbs of payload weight each were launched from the UND campus.
- All payloads were successfully recovered approx. 70 miles southeast of the launch site.
- Students were exposed to various aspects of an actual space “mission”.
- In the news: Murphy, C. (2019) ‘Reaching New Heights with North Dakota’s youth’, UND Today, Grand Forks, 3 Dec.

## Conclusions

In summary, STEM is a highly important part of a student’s education. Knowing this, high-altitude ballooning is a cost-effective, interactive and fun STEM related project that students can engage with. Here we laid out a simple framework on how the NDSGC reaches students across the state of North Dakota to engage in STEM. Through nine iterations of this event, we believe other institutions could incorporate similar projects and achieve similar success.

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Students from Shiloh Christian School presenting their payload project during Integration Night.