Mission INSPIRE: Soaring to Excellence in Data Analysis for Students With Visual Impairments

BY TIFFANY WILD, TINA HERZBERG, AND L. PENNY ROSENBLUM

Students with visual impairments are often the only students at their school who read braille. They often do not participate in science fairs, in some cases because of low expectations on the part of educators and in other cases because of accessibility challenges. Yet science fairs are a valuable way for students to build skills (Welsh, Hedenstrom, and Koomen 2020). The Next Generation Science Standards (NGSS) focus on engineering design in the middle school years while testing models where only one variable is changed from trial to trial (NGSS Lead States 2013). The emphasis is on design and communicating about the data gathered, analyzed, and interpreted. With adaptations, students with visual impairments can, and do, learn these skills.

While the Perkins School for the Blind (see Online Resources) has provided an overview of how students with visual impairments can be included in science fairs, there has been no documentation of students’ participation beyond a few pictures and suggestions on the school’s website. No research could be found that documents the experience of students with visual impairments in science fairs. The authors emailed major science fair organizations asking if they had any students with visual impairments involved in their fairs, and no replies were received. For this project, general methods for teaching science to students with visual impairments were referenced (Wild and Koehler 2017) as well as the experience of the teachers leading the course. All were certified teachers of students with visual impairments and/or certified STEM teachers.

For the past two years, Project INSPIRE: Increasing the STEM Potential of Individuals Who Read Braille, a U.S. Department of Education grant-funded project, has increased knowledge of students with visual impairments with the braille code (Nemeth Code) used for mathematics and science. In addition to offering direct instruction in braille symbols through our Nemeth in a Box program, we developed Mission INSPIRE, a science-fair-like activity for middle school students. Mission INSPIRE provided science and engineering practices while bringing together students with visual impairments throughout the country.

Planning the first science fair mission

Planning began with the help of an advisory board. During a meeting to select a theme, an advisory board member suggested we focus on rocketry, due to media coverage of launches from NASA and SpaceX. It was decided to use the Civil Air Patrol Model Rocketry Curriculum (see Online Resources).

The Mission Control team (five teachers, three of whom are researchers) planned for and organized the activities. They developed a recruitment flyer, registration materials, and a judging rubric. All directions for building a “fizzy flyer” rocket, and background information on rocketry was prepared in braille. IRB approval from the University of South Carolina and The Ohio State University was obtained.

Seventeen students called rocket scientists, ages 11 to 15 from across the United States, were recruited.
to participate in the mission. All rocket scientists were sent a box of materials that contained a braille and print copy of background materials from the curriculum, the instructions for building the rocket, and a plastic bag filled with build materials for the rocket including:

- two 4 in. × 4 in. pieces of cardstock paper
- two paper drinking cones
- one roll of tape in a box
- two packets of Alka Selzer tablets
- three triangles precut for fins that were paper clipped together
- two 35 mm plastic film canisters with lids

**Building rockets online**

Mission Control and the rocket scientists met for two hours on a Saturday morning via Zoom. We began the session with a review of all the accessible commands for use of Zoom. For example, many users of Zoom use a click of a mouse on the picture of a microphone to unmute. However, if you cannot see the icon, you must use functions on the keyboard for the same action. For this task, holding down the space bar is another way to unmute.

All rocket scientists had their cameras on during instruction. Once students knew how to participate in the session, the building of the fizzy flyer rockets began. The rocket scientists were asked to get all materials from their box and have them in front of them. Because you cannot visually show each step of the build to the rocket scientists, two teachers taught each step of the build using the directions provided in the Civil Air Patrol manual, while making accommodations to the descriptions in the manual. Instead of referencing the visual pictures provided in the manual for each step of the build, teachers used a combination of mathematical terms and measurements for material placement throughout the build. For example, the teachers told the rocket scientists to place two fingers at the base of the water cone and make a cut to shorten the water cone. Rocket scientists were also told to place the fins at the base of the cylinder-shaped body with the triangles positioned to create a right angle in relation to the cylinder.

Throughout the build, rocket scientists asked the teachers for visual confirmation of their builds by sharing their rockets on camera. Teachers offered praise, confirmation, and feedback as needed. Rocket scientists also supported their fellow rocket scientists by offering encouraging comments and using different language than the teachers to convey the steps in building the rocket that they found helpful.

As Mission Control reflected on the build, we realized that many of our rocket scientists, due to limited or absence of vision, were unfamiliar with what rockets look like. They did not understand placement of the fins or the cylinder shape of the body of the rocket.
recommendation for future missions is to have a model rocket that rocket scientists can feel and study before and during the build. It would help to review, with a model, what the rocket looks like and where components are placed on the rocket such as the cone-shaped pointed nose. References could also be made to the rocket model throughout the build. While inclusion of the model would benefit our rocket scientists, all students would benefit from having a model of the object they are building.

Testing the rocket
The rocket scientists were given the opportunity to test the rockets at their own homes. They were also given precise directions in braille, and print for sighted helpers, of how to launch the rockets. The Alka Selzer tablet was placed in the canister of the rocket and mixed with water. A lid was then placed on the canister to cause a buildup of pressure to propel the rocket in flight. The sodium bicarbonate tablet was dissolved in the water, which produced carbon dioxide bubbles and gas (Jaramillo n.d.). The gas fills the canister, building pressure, forcing the rocket to project upwards as the lid of the canister remains on the launchpad and the pressure from the reaction is released.

Before the rocket scientists began testing their rockets, safety measures were reviewed with them at the end of our Zoom session. They were warned to conduct this experiment outside due to the reaction and the mess that it could cause. They were also warned not to walk in front of the rocket and move away quickly after water was added to the tablet. Indirectly vented safety goggles should also be worn during experimentation. The rocket scientists were told to complete this test after our Zoom meeting sessions under the guidance of an adult.

Supersecret mission
Following the group Zoom build session, the rocket scientists received an email containing an audio message from Mission Control, explaining their “supersecret mission.” The mission announcement directed the rocket scientists to build a second modified rocket, test it, collect data on the test flights, and then report their findings to Mission Control. Both the first rocket built together on Zoom and the second modified rocket were to be tested.

In addition to the directive to build a new rocket, the rocket scientists were told to reference a rubric to understand how they would be judged when presenting their findings to Mission Control. The rubric was based on a combination of several open-source science fair rubrics found online as well as one teacher’s experience in science fairs. The emphasis of the judging was on the following criteria: (1) explanation of the procedures used to make a new rocket and record data; (2) proper use of braille symbols; (3) conclusions drawn from the data collected; (4) presentation of the data, findings and articulation of the variables in the project; and (5) originality and creativity of the presentation and/or rocket second build. See Figures 1 and 2; see also the rubric in Supplemental Materials.

FIGURE 1: Materials for building the rocket are placed in a plastic bag [supplies include Alka Seltzer tablets, paper water cones, braille paper, tape, 35-mm film canisters, and paper triangles].
The rocket scientists were allowed to have “research assistants” to video record launches and/or assist them with the technical build of their new rocket. In addition to the research assistants, the rocket scientists were offered two drop-in sessions with members of Mission Control (on Zoom) to have any questions answered regarding their projects or presentations, to ask for clarification about components of the rubric, or to discuss the technical aspects of their project such as identifying variables.

**Presentations**

Three weeks from the time the rocket scientists built their first rocket, they met with Mission Control on an individual basis to present their findings. Mission Control members served as judges using the project rubric. Emphasis was placed on how the rocket scientists communicated their scientific understanding of variables, their hypothesis, data collected, and conclusions.

The rocket scientists’ presentations ranged from using PowerPoint to deliver content live to the creation of edited videos complete with music. They used assistive technology, including software that voiced the content on their PowerPoint slides, braille displays that attached to a computer and provided text on the screen in braille, and braille notetakers. They also used mainstream technology to record data and create their presentation materials (i.e., computers, iPhones, iPads, and Microsoft products).

Examples of modification in rocket design made by rocket scientists included increasing fuel, changing the number of fins, and varying the materials used in the build. When asked how they determined flight time, many rocket scientists discussed listening to the “pop” of kinetic energy created when the rocket took flight to hearing the crash on the ground at the end of the flight. The rocket scientists could hear the chemical reaction of water with Alka Selzer that fizzed as it acted as “rocket fuel.” Some rocket scientists took real-time data by counting the seconds between “pop” and crash while others did this as they reviewed their video.

**The Hatch Ceremony**

The week after presentations were made, the rocket scientists once again joined Mission Control virtually for the Hatch Ceremony. This was a time where accomplishments of each rocket scientist were celebrated. The ceremony began with a video compilation of small clips from each rocket scientists’ presentation. Throughout the video, the narrator provided audio description of the images and actions shown. This allowed each rocket scientist access to the work of others while learning about the methods and engineering used by each rocket.
scientist during the supersecret mission. In addition, a TED Talk from Dr. Wanda Diaz Merced (see Online Resources) was played for the rocket scientists so that they could hear from a blind scientist at NASA and understand how she completes her visual tasks. We also discussed Mission AstroAccess with the students to share how others with visual impairments were able to join a space mission for the first time (see Online Resources).

To end the Hatch Ceremony, the first, second, and third place winners and most creative rocket scientist were announced and received Amazon gift cards. All rocket scientists were congratulated by Mission Control as well as their research assistants and other family members.

**Rocket scientists success**

The Mission INSPIRE project was a huge success. We were able to show that students with visual impairments can participate successfully in a science-fair-type activity. Rocket scientists reported that they had fun building the rockets and enjoyed engaging their families in a science project specifically designed for them!

Comments gathered through a postsurvey from the rocket scientists included:

- I never made rockets until the project with Mission INSPIRE, so it was very informative and helpful in learning new things about rockets.
- My favorite part of Mission INSPIRE was making the rocket and editing the video myself. I also liked presenting my final product to the judges.

We advocate for the full inclusion of all students with disabilities, including those with visual impairments in all STEM-related activities including science fairs. The Online Resources include information about how to teach science to students with visual impairments. Our rocket scientists were able to successfully participate in building a rocket, gathering data, and communicating about their learning completely. We encourage teachers and administrators to follow our example and advocate for inclusive science fairs and to promote those opportunities for our students with disabilities, including those with visual impairments.

**ACKNOWLEDGMENT**

The research reported in this article was funded by the U.S. Department of Education, Office of Special Education and Rehabilitative Services [Grant Number H235E1090003]. The views expressed are not necessarily those of the funding agency.

**REFERENCES**


**ONLINE RESOURCES**

Civil Air Patrol Model Rocketry Curriculum—https://tinyurl.com/we5ua5a

Wanda Diaz Merced TED talk—https://tinyurl.com/2t8yw2s

Mission AstroAccess—https://astroaccess.org/

Perkins School for the Blind: The science fair is for everyone—https://tinyurl.com/2p86a8dn

Strategies for teaching science to students with visual impairments—https://www.nsta.org/visual-impairments

**SUPPLEMENTAL MATERIALS**

Mission INSPIRE rubric—https://tinyurl.com/wfzhmz96

_Tiffany Wild* ([wild.13@osu.edu](mailto:wild.13@osu.edu)) is an associate professor in the Department of Teaching and Learning at The Ohio State University in Columbus. Tina Herzberg is a professor at the University of South Carolina Upstate in Spartanburg, South Carolina. L. Penny Rosenblum is the owner of the consulting company Vision for Independence, LLC and research professor emerita at the University of Arizona in Tucson._