REMAKING SCIENCE FAIRS

Adaptations create science conventions that avoid the typical pitfalls of science fair time.

BY DENA HARSHBARGER

For some, the phrase, "science fair" conjures up exciting memories of fizzing soda bottles, erupting volcanoes, and eye-catching poster displays. Unfortunately, for others, the phrase dredges up feelings of anxiety and scientific inaptitude due to several common practices. First, science fairs are typically competitive in nature (Barth 2008). Projects are judged and one student is declared the winner. Second, science fair projects are often judged more by "glitz versus substance" (Robertson 2008, p. 71), so rather than looking for evidence of students' scientific-process skills and subject knowledge, judges are often swayed by the aesthetic appeal of the display. Third, science fair projects have historically been assigned as homework. This can limit the type of project or question students pursue due to the availability of supplies or lack of parental involvement and home support. In contrast, some parents purchase extravagant supplies and even complete the project *for* the student. As a result, many homework-based science fair projects do not reflect students' true abilities and learning. Therefore, in my current role as an elementary science methods instructor at a small midwestern university, I wanted to help teachers restructure traditional science fairs into *science conventions* to more accurately reflect how scientists share their findings within a scientific community (Barth 2008). Traditional science fairs convey a festival or carnival atmosphere in which students entertain their audience by repeatedly performing their investigation with little to no emphasis placed upon scientific process or content knowledge. In contrast, the primary goal of *science conventions* is that all students successfully meet the targeted standards and learning objectives. Thus, scientific process and content knowledge is stressed and highlighted throughout the learning experience. During the day of the science convention, participants do not conduct the actual investigation, but instead, repeatedly share the results and conclusions of their investigation in an exposition-type atmosphere similar to that of a "piano recital" (Barth 2008, p. 85). Emphasis is placed upon exposition etiquette, such as being respectful and attentive to participants and learning science from one another.

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Documenting an investigation.

One way to address the concerns associated with the traditional science fair was to capitalize on the partnership that existed between my university and a local elementary school. I contacted a fifth-grade teacher at the school, who is a strong advocate of inquiry-based instruction, and she and I designed a science convention for her fifth graders. A description of our collaborative journey follows. I hope our journey will inspire other teachers to borrow and adapt certain aspects of our experience to develop their own version of a science convention that will enable *all* of their students to successfully participate and learn science. See Figure 1, page 40, for suggestions for planning and facilitating a science convention.

Project Preparation

To offset concerns associated with out-of-school homework science fair projects, 25 of my elementary science methods students (i.e., preservice teachers at the university; PSTs) would travel to the elementary school to work with 32 fifth-graders during regularly scheduled class time. Two weeks before the project began, the fifth-grade teacher and I met to strategically partner one or two fifth graders with a preservice teacher (PST) according to students' interests, personalities, and background knowledge.

If university preservice teachers are unavailable and you are interested in organizing a science convention using a collaborative approach, consider the following partnerships:

- Partner elementary students with middle or high school science students.
- Recruit parents, grandparents, retired teachers, or community volunteers to partner with elementary or middle school students.

FIGURE 1.

Suggestions and recommendations for hosting a science convention.

- **Create a timeline.** A timeline breaks down the long-term project into more manageable segments while also providing focus and accountability for learning.
- **Prepare a science packet.** A packet provides structure and guidance throughout the process. It also enables students to work at their own pace.
- **Request donations for materials.** After students generate their list of materials, create a cumulative list of requested supplies. Ask your school's Parent-Teacher Organization, volunteers, or community members to lend available items from home or donate inexpensive supplies. If materials are too expensive or unavailable, have students adjust or revise their proposed investigation. This process mirrors the way scientists often attempt to obtain funding for scientific research.
- **Emphasize scientific-process skills.** Encourage students to make predictions, make observations, collect quantitative and qualitative data, make inferences about the data, and communicate and share their findings.
- **Support and develop students' scientific explanations.** To scaffold this complex process, use a *claim*, *evidence*, and *reasoning* (CER) framework (Zembal-Saul, McNeill, and Hershberger 2012). Model and practice how scientists generate a claim, support the claim with evidence, and finally justify the connection between the claim and evidence using big ideas or science concepts (i.e., reasoning).
- **Pre-plan projects.** Ask students guiding questions to help them think through the logistics and purpose of the presentation (i.e., font, organization, and spacing). Before beginning the project, have students sketch out or make an outline of what to include on their poster or PowerPoint slides.
- **Differentiate according to students' academic readiness.** Due to the open-ended format of the science convention, students can potentially work at their own instructional level or Zone of Proximal Development (Vygotsky 1978). For instance, gifted learners can generate more complex questions and incorporate more sophisticated procedures. Conversely, the learning process can be scaffolded for struggling learners by allowing them to work in teams and/or use supportive technology (i.e., apps and spellchecker).
- **Develop a meaningful assessment instrument.** Based upon our experience, my recommendation is for the classroom teacher and students to collectively prepare and develop a scoring rubric suited to their unique situation. This collaborative process increases ownership in the learning process (Wiliam 2011).
- **Provide formative feedback.** As Sadler (1989) describes, formative feedback promotes individual growth and learning. Allow students to present and respond to one another using predetermined scoring criteria. Students can use peers' feedback and suggestions to improve their presentation before the day of the science convention.
- **Collaboration and communication.** The science convention format capitalizes on several literacy standards (NGAC and CCSSO 2010). Emphasize the use of clear, descriptive language and oral presentation skills to communicate findings with others. If possible, have students prerecord their presentations using iPads or similar technology. Allow them to watch their presentation, set goals, and practice presenting to classmates on multiple occasions to help them gain confidence and better understand their findings. If technology is not available, students can also practice for a "live" audience.
- **Student success.** Rather than judging students and selecting one "winner," use predetermined scoring criteria stemming from the *NGSS* (2013) and the *Common Core* (2010) so that all students can successfully complete and share their projects.

- If volunteers are limited, have students work in pairs or in teams to plan, conduct, and share the results of a collaborative science fair investigation.

The week prior, the fifth-grade teacher visited our university classroom so she and I could collaboratively share our expectations and answer questions about the upcoming science convention. During this time, she showed an example presentation previously made while she attended a summer science workshop. During the workshop, she had planned and conducted an investigation to determine which type of liquids evaporate fastest. Following her presentation, the PSTs practiced generating potentially useful science convention questions, identifying variables, and reviewing the inquiry tasks.

FIGURE 2.

Self-evaluation questions to help students select an investigable question.

Is there a specific answer?	YES	NO
Do I know how to find the answer?	YES	NO
Do I have enough time?	YES	NO
Can I get the materials I need?	YES	NO
Is it safe?	YES	NO
Is it ethical? (Good purpose)?	YES	NO
Is my question related to *States of Matter*?	YES	NO
Is it an original idea?	YES	NO
Am I truly interested in this question?	YES	NO

FIGURE 3.

Checkpoints: self-reflection, peer-reflection, and teacher feedback.

1) Have another scientist review your procedure before you continue your investigation.
Another fifth-grade scientist's signature:

____

- ❑ Ready to Go! Excellent detail. We can understand and follow these steps.
- ❑ Almost Ready! Add more detail about....

2) Have a teacher review your procedure before you continue your investigation.
Teacher's or mentor's signature:

____

- ❑ Ready to Go! Excellent detail. I can understand and follow these steps.
- ❑ You're making progress! Consider...

Science Convention Timeline

The PSTs and their assigned fifth grader(s) worked together for 50 minutes per day for 12 days. I created a timeline to break the project into more manageable segments and to provide a flexible framework to keep the participants on track (see NSTA Connection).

Day 1

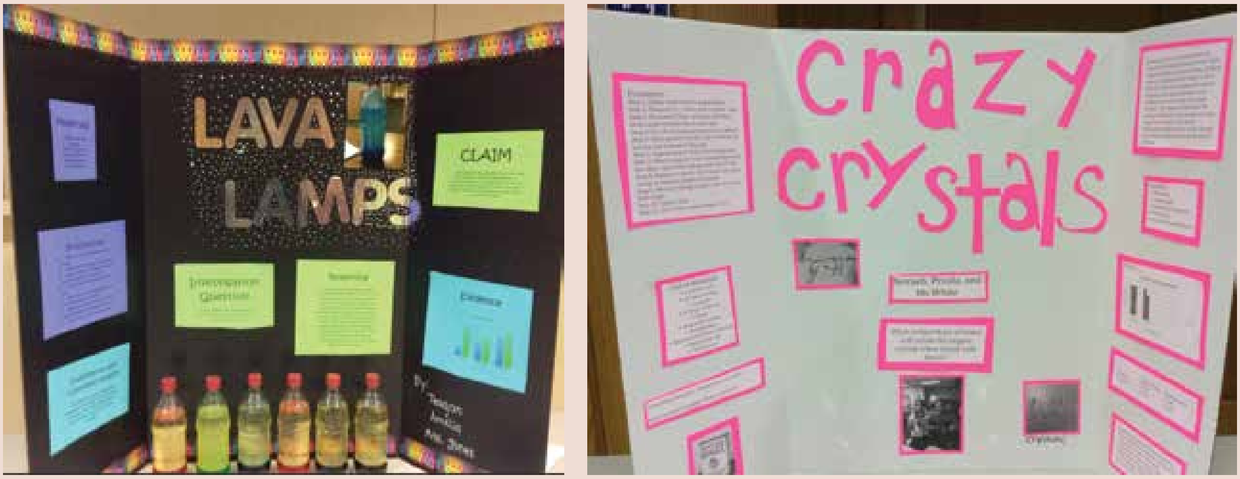
On the first day, the PSTs and fifth graders gathered in one classroom. While all participants were assembled, I provided an overview and described what a science convention is and is not. I showed photos from a previous science convention so students could envision the process and what they could expect on the day they presented their findings. I also explained how scientists record their work so it can be replicated or used as a basis for further research. Each fifth grader was given a science convention packet so they could record their predictions, procedures, results, and conclusions throughout their investigation (see NSTA Connection).

The fifth-grade teacher designated the theme of the science convention to be *States of Matter* (i.e., solids, liq-

A teacher assists students exploring melting points.

FIGURE 4.

Student project examples.



uids, and gases) since the students had just completed a unit about this topic. Therefore, the PSTs helped their student(s) brainstorm investigable questions related to this topic. The fifth graders self-evaluated the feasibility and safety of their idea using a series of questions (Figure 2, p. 41) found in the project packet (see NSTA Connection). Examples of students' investigable questions included: (a) Which liquid produces the most gas when added to Pop Rocks? (b) Which liquid melts ice faster? (c) If we change the temperature of water, how long will it take Alka Seltzer to fizz? and (d) What temperature of water when mixed with Borax will create the largest crystals?

Day 2

The fifth graders recorded predictions, identified variables, and described their proposed procedures for exploring their investigable question. To ensure that the fifth graders clearly described their procedure, I added checkpoints (see Figure 3, p. 41) within the project packet. The first checkpoint required the students to ask another science pair to assess their procedures for clarity. The second checkpoint enabled the fifth-grade teacher or me to check for clarity, safety concerns, and availability of materials.

The classroom teacher and I were able to provide most of the requested materials. However, due to budgetary constraints, the PSTs were responsible for providing consumable items that were not on hand at the university or elementary school (i.e., soda pop, Mentos candy). We suggested students select an alternate investigation if cost of materials was a concern. The students responded favorably to these parameters.

Days 3 and 4

In accordance with the *Next Generation Science Standards* (NGSS Lead States 2013), the fifth graders planned and conducted investigations to answer their questions. To create a fair test, they controlled variables and used multiple trials. As the students tested their investigative procedures, they were encouraged to modify and improve them based upon the test results.

The PSTs facilitated and ensured that proper safety precautions were taken during the investigations (see NSTA Connection). "Messier" investigations were conducted outdoors or in the school cafeteria. While the fifth graders conducted their investigation, they recorded quantitative data using metric measurements and qualitative data in the form of detailed descriptions and photographs taken with iPads.

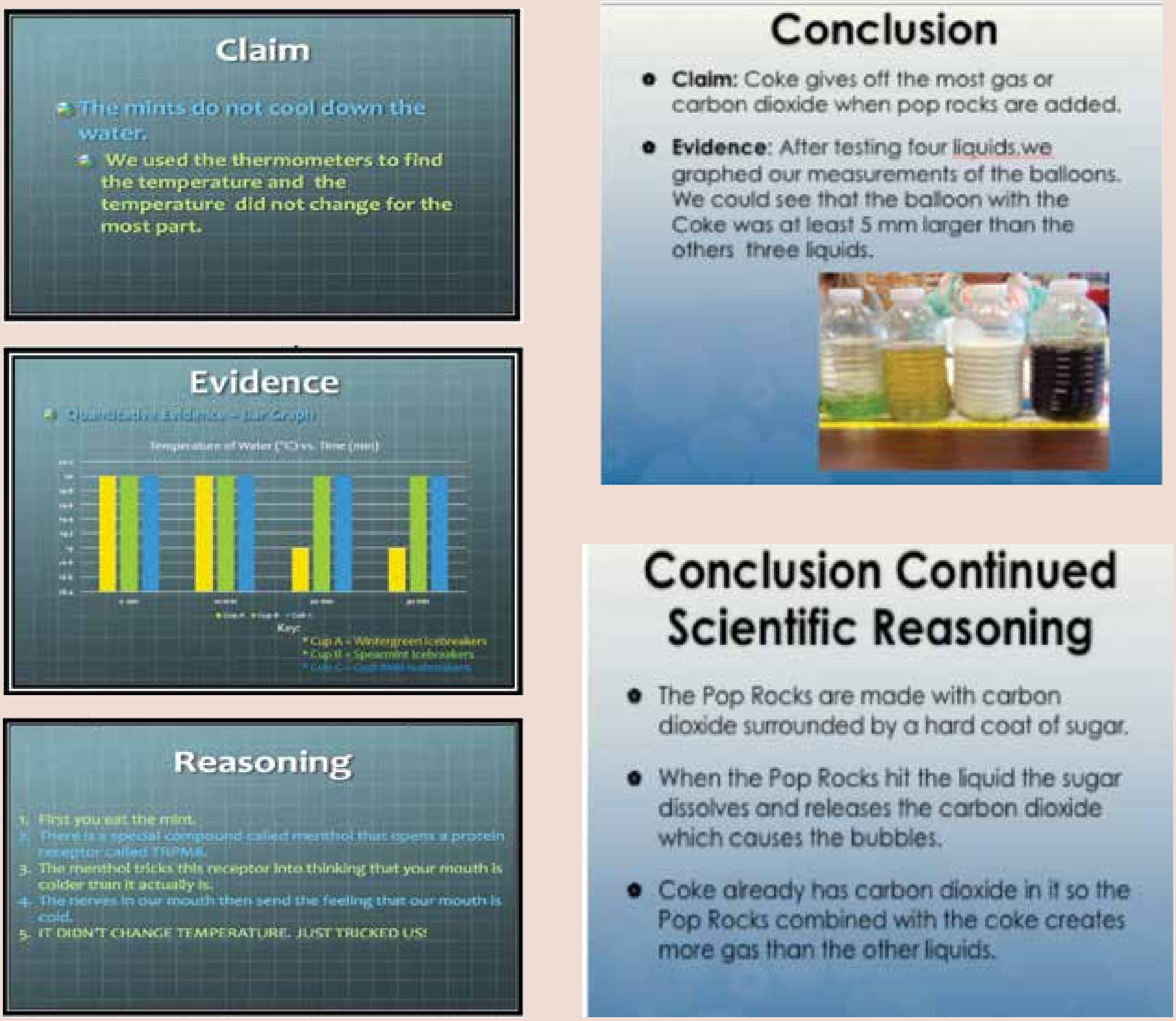
Days 5–8

During the next four days, the fifth graders analyzed and interpreted their data using questions found in their project packet:

- What do you notice about your data?
- If you conducted multiple trials, were the results similar or different? How can this be explained?
- Are there any patterns in the data?
- Explain what your data suggests.

FIGURE 5.

Projects using the Claim, Evidence, and Reasoning model.



Next, students used classroom computers or iPads to research scientific explanations that either substantiated or refuted their claims. As shown in Connecting to the *Common Core State Standards* (p. 45), this portion of the project aligned with several literacy (i.e., writing and research) standards (NGAC and CCSSO 2010) and was differentiated according to the fifth graders' Zone of Proximal Development (Vygotsky 1978). Vygotsky's (1978) Zone of of Proximal Development (ZPD) is the level of instruction determined to be one step beyond what a child can learn or do independently. In this instance, all of the fifth graders were able to scientifically explain their claims when provided the appropriate level of support or scaffolding. For instance, one student was verified as having difficulty with motor skills and subsequently had an Individualized Education Plan (IEP) suggesting that he respond orally instead of writing lengthy responses. In this situation, the PST used an iPad app called "Dragon Dictation" to audio-record and transcribe the students' ideas.

As previously described, instead of having students repeatedly perform their investigation for the audience as is typically done at science fairs, participants in a science convention repeatedly share the results and conclusions from their investigation (Barth 2008). Therefore, once the students' investigations were finished, attention shifted to preparing for the science convention presentations. The fifth graders decided what type of presentation (i.e., poster or PowerPoint) they wanted to use to share their findings. Before beginning the project, the fifth graders sketched out a plan showing what they would include on their poster or on each PowerPoint slide. To help the fifth graders think through the logistics and purpose of the project, the PSTs asked questions like:

- What information should be included?
- How should the findings be organized and displayed so the audience can understand what you discovered?
- What type of font would be easiest for the audience to read?

Figure 4 (p. 42) shows examples of fifth graders' completed poster projects. Figure 5 (p. 43) shows the *claims*, *evidence*, and *reasoning* portion of two students' PowerPoint projects (Zembal-Saul, McNeill, and Hershberger 2013). (Note: The projects were not always perfectly polished and sometimes contained spelling errors; however, they reflected the student's work and understanding of the topic.)

Days 9–11

This portion of the science convention also reflected several speaking and listening standards (NGAC and CCSSO 2010). After a few informal practice presentations, the fifth graders video recorded their presentation on an iPad. As they watched the video recording, they identified strengths and ideas for improvement. For instance, many students noticed that they needed to talk louder or they needed more eye contact.

Additionally, a three-part scoring rubric was used for (a) self assessment; (b) peer assessment; and (c) teacher assessment. The scoring rubric included 10 statements relating to the quality of the students' scientific process and presentations. These statements addressed the feasibility of the students' investigable question, prediction, procedures, data collection, and claim based upon existing evidence, as well as the clarity of information shared in the presentation. Students were scored using a 0–2 point scale:

0 = No evidence

1 = Some evidence

2 = Yes, much evidence

First, the fifth graders completed Part 1 of the self-reflection portion of the rubric (see NSTA Connection). They recorded their self-reported scores for the 10 statements. If they discovered a weaker area, they made adjustments to this portion of their project to improve their self-reported scores. Next, the fifth graders presented to other pairs (i.e., PST and fifth grader). These pairs provided suggestions based upon the same 10 statements (i.e., Part 2 of the rubric). For instance, if the pair of peer reviewers determined the data was not displayed in an easy-to-read graph or table, they would award a score of zero or one for this particular statement on the rubric. They also orally shared suggestions for improvement. This formative feedback helped the fifth graders make adjustments and also increased their self-confidence before the actual science convention (Sadler 1989). As a result, when the classroom teacher recorded her summative scores for the 10 statements on Part 3 of the rubric, it was determined that *all* of the fifth graders had proficiently met the scoring criteria for the science convention project.

Day 12

On the day of the science convention, several lunchroom tables were arranged into a horseshoe shape along the perimeter of the cafeteria, creating a large open area for guests to view the fifth graders' presentations. Next, the fifth graders set up their poster or PowerPoint in an assigned location before their audience arrived. PowerPoints were shared using iPads and Chromebooks.

To ensure that there was always an audience available,

A student confidently shares her findings.

Connecting to the *Common Core State Standards* (NGAC and CCSSO 2010):

Common Core State Standards Connections	Connections to Classroom Activity *Students:*
CCSS.ELA-LITERACY.W.5.7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of the topic.	reference two or more sources to locate scientific information to explain and substantiate their claims.
CCSS.ELA-LITERACY.W.5.8: Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.	summarize relevant information from print and digital sources in their science convention packet and finished project and list sources in their science convention packet.
CCSS.ELA-LITERACY.SL.5.4: Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.	communicate the results and conclusions of their investigation to K–4 students, peers, teachers, administrators, and parents during the science convention.

the K–4 teachers signed up for 20-minute time slots to bring their students to visit the science convention. Additionally, the classroom teacher sent home an invitation with each fifth grader one week prior to the event. As a result, several family members and friends were in attendance during the science convention. Some visitors popped in for a few minutes, while others, including the school administrator, stayed for the entire hour.

The fifth graders' presentations typically lasted between two and five minutes. Since the length of the presentations varied, we elected to use a flexible rotation schedule that better simulated a science convention. This minimized downtime and allowed students and audience members to present and visit presentations at their own pace. Once a presentation ended, audience members asked questions or shared something they learned from the presentation. Next, the audience members simply looked around the cafeteria to find a different fifth grader who had recently finished their presentation and was ready to share with a new group of audience members. Using this format, students shared their findings and fielded questions pertaining to their investigation on multiple occasions. Over the course of the 12-day experience, students were able to view all of their peers' presentations.

After successfully participating and learning, *all* students felt as if they had "won." I hope our winning experience inspires others to conduct their own version of a science convention. ■

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NSTA Connection

Download the timeline, project packet, safety precautions, and assessment at *www.nsta.org/SC1609*.