Using Biographical Letters to Draw on the Nature of Science

by William Medina-Jerez, Wayne Melville, and Dale Walker

Science is a human activity with a rich, colorful, and controversial history. Teaching science from a historical perspective can influence the way students perceive, understand, and apply scientific concepts and processes. Perhaps more importantly, it can unlock the world of scientists, revealing their brilliance, their flaws, their perseverance, and their struggles with the consequences of their discoveries. By making them human, we make them more accessible to students. Accessibility is important if students are to become interested in and motivated about science, begin to see the social impacts of science, have opportunities to develop scientific literacies, and experience

authentic science. This article describes one strategy that is successfully being used in middle school classrooms to portray science as a human endeavor.

Biographical letters

Biographical letters is a strategy that gives students the opportunity to view scientists as real people who, like them, belong to real communities and pursue real interests. Using biographical letters allows students to see the scientist as a person and recognize that science is more than the finished products they see in texts. These stories capture an important element that has long been absent in science teaching: "being told where we are now (knowledge of science), without being told how we got there (knowledge about science)" (Wandersee 1992, p. 428). Through biographical letters, students become invested in the course of events presented in the story and become protagonists, reclaiming the role and contributions of a scientist.

Using the supplementary material

In developing this article, we created and made extensive use of supplemental materials that can be accessed on the NSTA website at *www.nsta.org/middleschool/connections.aspx*. This material, including a biographical letter with suggested prompts for discussion and bibliographic resources, should be used in conjunction with what is presented on these pages.

Preparing the letter

To prepare to implement biographical letters in the classroom, first select a narrative that considers both the scientist's work and the social and historical context of that work. This important step can be used to recognize the variety of voices within your classroom (Monk

FIGURE 1 Developing the biographical letter

With Jardine's (2005) biography of Robert Hooke acting as the main information source for this activity, the design of the biographical letter, "The Boy from the Isle of Wight" (see sidebar, p. XX; the full letter is available with the online version of this article) was guided by the work of Wandersee (1992) and Monk and Osborne (1997). Consequently, it has the following features:

- The letter uses the first-person format. Students impersonate the scientist of their choice.
- Like most letters, this biographical format includes a purpose. In this case, the writer attempts to tell the reader about the unfair treatment that Hooke received from Isaac Newton. This conflict appears to have undermined Hooke's stature in the history of science.
- The letter highlights human features that the reader can use to contextualize the central episode of the letter (Newton destroyed Hooke's pictures hanging on the wall of the Royal Society).
- The letter is framed by the social and historical context and invites students to take sides.
- The scientist is depicted at different stages of his life (childhood, adolescence, adulthood). Students may see themselves represented in the story and therefore be more prone to share their views about participation in the scientific enterprise.
- The reading of the letter is interrupted, which allows for student participation at crucial moments of the story. See notations on the letter, available with the online version of this article, for appropriate interventions.
- The presentation and discussion of the central episode enhances the science content being studied.
- The letter ends with students becoming protagonists of the story. In this case, students gain agency by reviving the name and image of Robert Hooke through the portrait they produce based on the physical description offered by Jardine. The use of drawings is an inviting way to have students engage in the concept being studied. Other art-related strategies, such as biographical kits, will also assist students, especially English language learners, to communicate their understanding of the topic (Figure 2).

Plan to evaluate students' understanding of the issues and connect the story to lesson goals about the history and nature of science. Practical applications of this letter can be found when addressing content such as the gas laws, cell theory, and Newton's laws of motion.

and Osborn 1997). Why was the work of Caroline Herschel, for example, not given the contemporary recognition it deserved, and what prejudices did George Washington Carver face in his work? We have provided some examples of suitable scientist biographies that you may wish to consider in "Biographical Resources," available with the online version of this article.

Second, be sure to use examples that add richness and depth to the topic you are teaching and your current instructional objectives to avoid diluting the content. Third, be intentional in what you plan for students to gain from the exercise. For example, in this article, we examine the life of a scientist whose contributions have historically been minimized, because we wanted our students to understand the impact of personal and sociocultural factors on the traditions of merit and recognition in the wider scientific community.

Developing the biographical letter

A biographical letter must engage students in the biographical first person, develop the social or historical context for the scientist's work and life, and highlight the controversies that scientists experience in their lives and work. Figure 1 lists general guidelines we have created for developing stories that depict scientists as people, derived from the work of Wandersee (1992) and Monk and Osborne (1997).

In our letter about Robert Hooke, we chose to give students only his first name. Textbooks often identify scientists by their last names, but by reading about Hooke as "Robert," students may perceive him in a more personal manner. The last name was also purposely left out because we wanted to know whether the students would be able identify a scientist associated with a major concept in biology (the cell). Asking the students for Robert's last name after reading each paragraph additionally enticed them to read further.

Using the biographical letter

After we developed a biographical letter for Hooke (see sidebar), we used the following strategies to engage students with the material. This section should be read in conjunction with the prompting questions found at the bottom of "The Boy from the Isle of Wight" (see sidebar and the online version of this article).

First, students are asked to think of, and volunteer, the names of scientists they know. Typically at the top of the list are famous names such as Albert Einstein and Isaac Newton. Other students may mention less well-known names such as Marie Curie and James Watson. Quite often, students also mention inventors, such as Nikola Tesla and Thomas Edison. Ask students whether

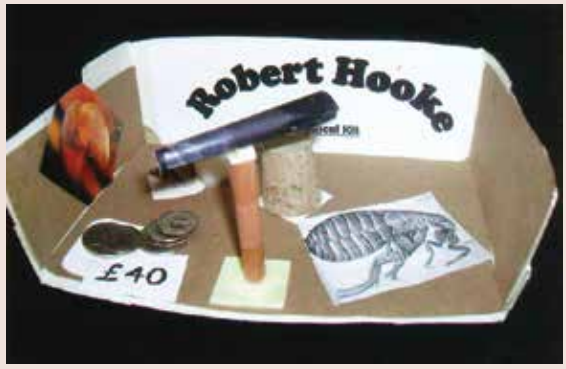
Biographical letter excerpt: "The Boy from the Isle of Wight"

Note: The full letter is available with the online version of this article.

Student drawing of Robert Hooke

My father died when I was 13 years old. He left me £40, all his books, and a chest to carry them. Before my father died, I was sent to London during the English Civil War, which lasted six years. In London, I was an apprentice to a Dutch painter, and then at the age of thirteen, I entered Westminster School. I went to Oxford University on a choral scholarship, which lowered my tuition fees. At Oxford, I studied astronomy but never earned a degree. I spent this time assisting the top English scientist of the time, Robert Boyle. I even designed a pump for him that helped him deduce a famous gas law. In 1662, I was named the curator of experiments for the Royal Society of London. As part of my duties, I was required to demonstrate three or four experiments at every meeting. At the same time, I became professor of geometry at Gresham College, London, where I lived until my last days in a dormitory-like room. Unfortunately, I found myself promising too much to too many people in too many projects. As a result, I left tasks unfulfilled, problems half-solved, and friends, clients, and patrons disappointed. However, I am proud to say that as a result of my work in microscopy and my artistic skills, my first achievement in science was recognized worldwide with the publication of my book *Micrographia*—a collection of beautiful drawings based on my studies with my homemade compound microscope. It was a best-seller! I was quite interested in looking at cork slices, and I coined the term *cell*.

FIGURE 2 Biographical kit on the life of Robert Hooke



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they have ever met a scientist or read about the lives of these individuals. If they have, ask them to describe the scientist's personality.

After a discussion about the ways in which students are familiar with the names on this unsurprising list, they are given a copy of the biographical letter. They are told that they will learn about the life of a scientist they might know, whose first name was Robert. Students take turns reading parts of the letter aloud. After reading each paragraph, students are interrupted and the class is asked to comment on that section of the letter (see suggested student questions with "The Boy from the Isle of Wight," available with the online version of this article). Students are also asked who they think the scientist is, and they often volunteer incorrect names, even after the paragraph mentioning how this scientist coined the term *cell*.

After reading the first half of the letter, students debate the reasons for the discordant events mentioned; explanations may include Hooke's pride, his leaving clients dissatisfied because he always overcommitted, and intellectual disputes with Isaac Newton. Students also share their views on Newton's attitude toward Hooke. Questions such as, "Do scientists compete?" and "Why would scientists compete for new information and for recognition?" can be asked at this point to explore students' ideas about how science, as practiced in the past and today, is affected by personal and sociocultural factors in the scientific (and wider) community. The pause also allows teachers to address subjectivity in the practice of science through a discussion of scientific inquiry and its purpose. Teachers can ask, "Is this the only process for conducting scientific investigations?" Other questions in the biographical letter address this point (see the online version of this article).

Opinions often are divided on the most reasonable solution to the disagreement that led to Hooke being forgotten. To the disappointment of those supporting the idea of giving Hooke fair treatment, other students have claimed that the ultimate solution would have been for Hooke to have abided by the norms practiced in the scientific community. Finally, many students identify the scientist, having gained an understanding of the role he played in science.

Pre- and postdiscussions have centered on the roles status and personality play within the scientific community and how such forces led to Hooke's obscurity in the history of science. Teachers can ask questions such as, "What scientists who lived in the 17th or 18th century had an impact on our understanding of science? What did those scientists discover? What impact did those discoveries have on our current understanding of science?" Other discussions have focused on the attention the biographical letter paid to key features of the nature of science (i.e., curiosity, empiricism, communication, perseverance). Teachers can ask students, "How do the interactions of Newton and Hooke relate to the steps in the scientific process? What inquiry practices are observed in this letter? What practices are not observed in this letter?"

According to Jardine (2005), no contemporary portraits of Hooke are believed to exist. At the end of the activity, students are encouraged to honor this scientist by creating a visual description of him, based on the letter. In most renditions, physical features such as his nose, mouth, and eyes resembled the posthumous portrait in Jardine's biographical book that is believed to be of Hooke (last paragraph in "The Boy from the Isle of Wight"; see sidebar, p. 47, and the online version of this article). Additionally, it was interesting to note that students depicted Hooke as the stereotypical scientist: a man in a lab coat, wearing glasses, a pen in his pocket, and surrounded by research symbols. Once students finished their drawings, they were invited to present their pictures to the class as part of a showcase of portraits.

Formative assessment

The implementation of this activity takes place in a biology class, during a unit on cell theory. The presentation of the activity is accompanied by a prediscussion around students' knowledge of Isaac Newton and his prominent work and interactions with fellow scientists in the social context of the Royal Society. If students are not familiar with Newton, teachers can introduce him now.

After the showcase of the portraits, students have the opportunity to revise their original assumptions about scientists' personalities and interactions within the scientific community (see questions at the end of "The Boy from the Isle of Wight," with the online version of this article). Using the components of the biographical letter, students then write the purpose of the activity, the names of the scientists involved, the contributions of the scientists, the disagreement between Newton and Hooke, and a brief account on the history of the discovery of cells by Antonie von Leeuwenhoek and Robert Hooke. The drawing and the write-up establish a foundation for each student to understand the role of the scientist in the discovery of the cell.

Links to the *Next Generation Science Standards* (*NGSS*)

Highlighted in the *NGSS* (NGSS Lead States 2013) are the historical approaches to the science learning that assists students in achieving a conceptual understanding of scientific ideas. The following learn-

ing outcomes are addressed in this activity in connection to Understandings about the Nature of Science:

- Science is a Human Endeavor.
- Men and women from different social, cultural, and ethnic backgrounds work as scientists and engineers.
- Scientists and engineers rely on human qualities such as persistence, precision, reasoning, logic, imagination, and creativity.
- Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.
- Science Addresses Questions about the Natural and Material World
- Scientific knowledge is constrained by human capacity, technology, and materials.
- Science limits its explanations to systems that lend themselves to observation and empirical evidence.
- Science knowledge can describe consequences of actions but is not responsible for society's decisions.

Extension activities

After learning about the life and scientific contributions of Robert Hooke, students can design biographical letters based on the life of a scientist of their choice (see "Scope on the Skies: Standing on Their Shoulders," p. 78). The "Biographical Resources" (available with the online version of this article) include the names of some scientists who may be of interest to the students. Students can also be encouraged to write biographical letters about themselves, highlighting their prior formal and informal learning experiences in this subject and features of their personality that they think may influence the way in which they approach and understand science .

Conclusion

Biographical letters encourage students to view scientists as human beings who are just like other individuals in our society. Recreating science stories that can be readily implemented in the classroom adds richness and authenticity to the teaching and learning of science, and cross curricular connections support a holistic understanding of science when students are presented with links to other scientific areas.

As school subjects become more integrated, this approach favors the possibility of working across content areas, collaborating with teachers from other departments (e.g., social studies) in the teaching of topics such as the Renaissance, the Industrial Revolution, and the role of underrepresented minorities in science. Science teachers who promote the nature of science in their classrooms may find in the biographical letter a practical example of an engaging activity for their students. ■

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Resources

The story of science—*www.joyhakim.com/events.htm*

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William Medina-Jerez (*wjmedinajerez@utep.edu*) is an associate professor of science education at the University of Texas at El Paso in El Paso, Texas. ***Wayne Melville*** *(wmelvill@lakeheadu.ca)* is an associate professor of science education at Lakehead University in Thunder Bay, Ontario, Canada. Before taking this position in 2005, he was a secondary science teacher in Australia for 17 years. ***Dale Walker*** *(walkerda@d93.k12.id.us)* is a science teacher at Bonneville High School in Idaho Falls, Idaho.