Lesson Plan
Scientific Writing in the Physical and Astronomical Sciences

Portrait of Mary Somerville

Drawing of Jane Marcet

Grade Level(s): 9-12	**Subject(s): Physics, Astronomy, History**

In-Class Time: 55-105 minutes	**Prep Time: 20-30 minutes**

Materials

- Student Internet access
- Handouts of the Introductions and Prefaces, as well as any desired handouts on subjects from the books (included in Supplemental Materials)

Objective

Students will learn about scientific writing by two women writers—Mary Somerville and Jane Marcet—from the early 1800s. Somerville and Marcet were highly recognized in the scientific community for making science accessible to everyone, especially to women and the lower classes. Students will read excerpts from both Somerville and Marcet's writing. The excerpts should be chosen by the teacher to be on a subject the students have recently learned. The students will also write their own explanations of the subject matter.

Introduction

The early 1800s were a period of rapid change. The Industrial Revolution was occurring, Romanticism was reacting against it and the landscape of the scientific world was shifting dramatically. With increasing technological advancements, the public grew to appreciate the sciences much more. However, at the turn of the century, science was largely dominated by men. Many of the scientific

societies were reserved for those who had enough money to spend their leisure investigating scientific topics and learning about them. There were no qualifications or standards for entry—it was simply fashionable.

Because science was in fashion in the aristocracy, it was expected that women also showed interest, no matter how superficial. This is how several notable women of the time made their way into the scientific limelight and flourished.. Two women in particular became exceptionally well known and were in the thick of the scientific community— Mary Somerville and Jane Marcet. They wrote the books that were classroom staples for the next three generations.

Mary Somerville was born in Jedburgh, Scotland on December 26, 1780. Her family was aristocratic only in name and family ties; they had no money to speak of. Growing up in rural Scotland, Mary was a wild child, who still had not learned how to read or write by the age of 10. A brief stint in a boarding school for girls sparked her initial interest in mathematics, but it wasn't until later that her talent in mathematics and science would be recognized.

As a young woman, she was very beautiful and extremely popular. She married early to a man named Samuel Greig. Their marriage was not a happy one, but it was short. He died after several years, at which time she began an apprenticeship with natural philosopher, Professor John Playfair. As an aristocratic woman, it was not unusual for her to be an apprentice because science was fashionable.

A few years later, Mary met her second husband, William Somerville. Having both been widowed early with young children, and sharing a passion for science and math, they made a fine couple. They moved to London in 1816 where they were instantly successful at making friends and integrating themselves into the scientific community. One of their first acquaintances were the Alexander and Jane Marcet.

Jane Marcet (neé Haldimand) was born on January 1, 1769 in London. She was homeschooled and married Alexander Marcet in 1799. He was a Swiss medical doctor and encouraged his wife's interest in science. They had a home-built laboratory and she attended lectures at the Royal Institute. However, the lectures were not always clear, and Jane struggled to understand visually what was really happening. She could figure most of it out at home, but in realizing that most people did not in fact have home laboratories, she decided to write her own book with pictures. This book explained and detailed much of what she learned in the Royal Institute's lectures.

She published this book in 1806. Not only did it become a staple of classrooms for many years, it continued to develop throughtwenty editions. While she started out publishing it anonymously, by the 1830s she was putting her name on the works. Her book, *Conversations on Chemistry*, sparked the interest of a young bookbinder by the name of Michael Faraday. By the early 1830s, Faraday's own work would be included in the new edition.

Jane also wrote textbooks on other subjects, including natural philosophy (or physics, at the time) and economics. Having Marcet as a friend undoubtedly influenced Mary Somerville while her writing her own book, *On the Connections of the Physical Sciences*. This book, like Marcet's, would become a staple in classrooms and society. Both books were aimed at women and the poor, both of whom had far fewer opportunities to study such topics as chemistry or physics.

Mary's book is exceptional in that it helped determine the particular subjects that are contained in physics today. Prior to her writing this book, there had been several attempts by high-profile scientists to better define the particular branch of science that would become physics. Because the book discussed the connections between these various subjects, those included were almost universally accepted as falling under the heading of physics.

Both women were publically recognized and highly well known for their time. The ease with which they participated in the scientific community speaks to the openness of science at the time, where anyone with an interest was welcome.

Instructions

Engage: 15 Minutes

Introduce the students to the concept of scientific writing by having them explain something they've learned in class using only the 1000 most common words in the English language. This is easily done by using the xkcd Simple Writer (found here and in the Required/Recommended Readings and Resources). Show them the original web comic (found here and in the Required/Recommended Readings and Resources) to give them an idea of what that looks like.	
What is the teacher doing? Introduce the students to the concept of scientific writing by engaging the students in a brief discussion on how to explain something to someone who don't know about it.. For example, ask how they might explain the internet to someone from the 1800s.. Make sure to get the point across that an explanation has to use language and vocabulary that is consistent with that of the explainee in order for it to be effective. To have the students practice this and get them thinking, have each student get on a computer and access the xkcd Simple Writer. Either give them a subject from class, or have them pick a subject of their own choosing to explain in the Simple Writer. After a few minutes, have some students share out what they wrote, and if they picked their own subjects, have the rest of the students guess what they were explaining.	**What are the students doing?** Students should listen and engage in the brief discussion on explaining. Get on the xkcd Simple Writer and explain either the subject the teacher gave or one of their own choosing. If selected to read their explanations, and if they picked their own, the rest of the class should attempt to guess what they were explaining.

Explore: 20-30 Minutes

Briefly introduce the students to Mary Somerville and Jane Marcet. Have them read the Preface and Introduction of Somerville's *On the Connections of the Physical Sciences* and the Notice and Preface of Marcet's *Conversations on Natural Philosophy* (included in the Supplemental Materials). Have the students also read any excerpts which the teacher chooses that are about subjects already covered in class. The links to the online books, accessed for free through the Hathi Trust, are provided in the Recommended/Required Readings and Resources. Select excerpts on subjects usually covered in physics and astronomy classrooms have been included in the Supplemental Materials.	
What is the teacher doing? Pass out the Preface handouts for both books, as well as any desired pre-made excerpts. If none of the pre-made excerpts work, choose appropriate excerpts from the books online and have the students read those. As the students read, have them note any vocabulary words or phrases that are unfamiliar or confusing. Make sure to go over all of them and be aware that there might be a few older concepts written about that have since been discarded by further scientific evidence. If this occurs, use the opportunity to talk about how science is always expanding. Talk about the fact that while we currently have a Theory of Gravitation, one piece of solid evidence to the contrary could be cause for dismissal. Make sure the students understand the different definition of theory in this case. A scientific theory is a well-substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment.	**What are the students doing?** Read the handouts and any online excerpts assigned. As they read, students should make note of any new or unclear vocabulary or unfamiliar phrases. They should make sure they understand what they mean before moving on to the next part.

Explain: 20 Minutes

Once the students have finished reading the excerpts, give them more background on Mary Somerville and Jane Marcet. Have the students discuss why they think these women were able to come to such prominence in the scientific community at a time when women were generally still considered unable to participate in science and higher education.	
What is the teacher doing? Give more background information on Mary Somerville and Jane Marcet. Lead a discussion on how these women were able to succeed and gain recognition. Fill in any gaps and explain the reasons if they can't come up with why	**What are the students doing?** Listen to the information on Mary Somerville and Jane Marcet. Participate in a discussion about how and why these women were able to succeed in writing about science at a time when women weren't considered fit for scientific pursuits.

themselves. Use the information in the introduction if necessary. Possible discussion questions with suggested answers are included below.	

Elaborate: 40 Minutes or Optional Homework

Have the students think about how textbooks, particularly science textbooks, are written today. Going back to the engage activity, have the students write a section of a textbook on either the same material that they wrote on in the engage section or the same material they read about in the excerpts. This can be assigned as homework if necessary.	
What is the teacher doing? Have the students write a textbook section on either the subject they wrote about in the engage section or what they read about in the excerpts. The explanation can either be aimed at other students on the same level or to younger, less advanced students. This write-up can go through as many revision sessions as the teacher would like.	**What are the students doing?** Write and explain either the same thing that was explained in the Engage section, or the same subject covered in the excerpts, using modern but simple language geared towards other students.

Evaluate:

Evaluate the students on their explanations of a topic. Emphasis should be given to clarity, appropriateness of vocabulary for the intended audience (other students at the same level younger) and proper grammar and language use.

Required/Recommended Reading and Resources

- xkcd Simple Writer: http://xkcd.com/simplewriter/
- xkcd Up Goer Five Comic: https://xkcd.com/1133/
- Preface and Introduction from Mary Somerville's *On the Connection of the Physical Sciences* (included in Supplemental Materials)
- Advertisement and Preface from Jane Marcet's *Conversations on Natural Philosophy* (included in Supplemental Materials)
- Pre-made excerpts on relevant topics (included in Supplemental Materials)
- Content lists for both Mary Somerville's *On the Connection of the Physical Sciences* and Jane Marcet's *Conversations on Natural Philosophy* (included in Supplemental Materials)
- Hathi Trust: Jane Marcet's *Conversations on Natural Philosophy*: http://hdl.handle.net/2027/hvd.32044097015804
  Marcet, M. 1769-1858. (1829). *Conversations on natural philosophy: in which the elements of that science are familiarly explained, and adapted to the comprehension of young pupils.* Boston stereotype edition. Boston: Printed and published by Lincoln & Edmands ...
- Hathi Trust: Mary Somerville's *On the Connection of the Physical Sciences*: http://hdl.handle.net/2027/hvd.hnwst7

Somerville, M. (1853). *On the connection of the physical sciences.* From the 7th London ed. New York: Harper & Brothers.

Discussion Questions

1. **What sort of technological advances occurred during the early 1800s?**
   This was the time of the Industrial Revolution (generally 1760 – 1840). Many new inventions were coming out that would revolutionize daily life, among them cement, gas lighting, steam power and textile manufacture.
2. **How do you think the views on science changed during this time period?**
   This was also the time of Romanticism, a reaction against the Industrial Revolution. Emphasis was placed on nature and the ancient past. However, with all of the new inventions, the practical uses for science became increasingly apparent. Couple that with the financial gain of those who invested in new technology, and you'll find that learning about science became the fashion for the aristocracy. Note that both men and women of aristocratic backgrounds were expected to show interest in science.
3. **Why do you think it would have been appropriate for women to be scientific apprentices at the time?**
   For aristocratic women, it was almost expected that they hold an interest in science. For those who genuinely were interested, it was not uncommon to be an apprentice to a well-known science professor. It was allowed because while the women would learn the science, there was no precedent or expectation that they would actually utilize their knowledge in a scientific occupation, and so they were not seen as a threat to the men who were creating the scientific profession.
4. **So women could learn about science, but why would it be ok for them to write about it, effectively making it a career?**
   It was not uncommon for women to be professional writers at the time (ex. Jane Austen), and it was one of the few professions in which women succeeded. Because the women writers of science generally geared their work towards the masses, it was not odd that they would be popular. What is truly unique is that they became staple textbooks in classrooms across the UK and the US.

Further Reading and Additional Resources

- Chambers Patterson, E. (1983). *Mary Somerville and the Cultivation of Science, 1815 - 1840*. The Netherlands: Martinus Nijhoff.
- Neeley, K. A. (2001). *Mary Somerville*. Cambridge: Cambridge University Press.
- Secord, J. (2018). "Mary Somerville's vision of science." *Physics Today*, *71*(1), 46-52.
- Any contemporary textbook with a section on a corresponding subject to what the students read in the lesson.

Extensions

Related AIP Teacher's Guides on Women and Minorities in the Physical Sciences:

- Hertha Ayrton and the Seashore Waves

- Scientific Writing in the Chemical and Earth Sciences

Common Core Standards

For more information on Common Core Standards, visit http://www.corestandards.org/.

Reading: Informational Text	
CCSS.ELA-LITERACY.RI.9-10.3	Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them.
CCSS.ELA-LITERACY.RI.9-10.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language of a court opinion differs from that of a newspaper).
CCSS.ELA-LITERACY.RI.11-12.3	Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.
CCSS.ELA-LITERACY.RI.11-12.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).
Speaking & Listening	
CCSS.ELA-LITERACY.SL.9-10.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CCSS.ELA-LITERACY.SL.11-12.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
Language	
CCSS.ELA-LITERACY.L.9-10.1	Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
CCSS.ELA-LITERACY.L.9-10.2	Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.
CCSS.ELA-LITERACY.L.9-10.3	Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.
CCSS.ELA-LITERACY.L.9-10.4	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9-10 reading and content, choosing flexibly from a range of strategies.

CCSS.ELA-LITERACY.L.9-10.6	Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.
CCSS.ELA-LITERACY.L.11-12.1	Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
CCSS.ELA-LITERACY.L.11-12.2	Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.
CCSS.ELA-LITERACY.L.11-12.3	Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.
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CCSS.ELA-LITERACY.L.11-12.6	Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.
History/Social Studies	
CCSS.ELA-LITERACY.RH.9-10.4	Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.
CCSS.ELA-LITERACY.RH.11-12.4	Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).
Science & Technical Subjects	
CCSS.ELA-LITERACY.RST.9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
CCSS.ELA-LITERACY.RST.9-10.2	Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
CCSS.ELA-LITERACY.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
CCSS.ELA-LITERACY.RST.9-10.5	Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

CCSS.ELA-LITERACY.RST.9-10.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
CCSS.ELA-LITERACY.RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
CCSS.ELA-LITERACY.RST.11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
CCSS.ELA-LITERACY.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
CCSS.ELA-LITERACY.RST.11-12.5	Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
CCSS.ELA-LITERACY.RST.11-12.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
Subject Writing	
CCSS.ELA-LITERACY.WHST.9-10.1	Write arguments focused on discipline-specific content.
CCSS.ELA-LITERACY.WHST.9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
CCSS.ELA-LITERACY.WHST.9-10.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
CCSS.ELA-LITERACY.WHST.9-10.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
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Next Generation Science Standards

For more information on the Next Generation Science Standards, visit http://www.nextgenscience.org/.

Dimension One: Practices	6. Constructing Explanations and Designing Solutions 8. Obtaining, Evaluating and Communicating Information
Dimension Two: Crosscutting Concepts	**Will depend on excerpts chosen.**
Dimension Three: Disciplinary Core Ideas	*Capillary Attraction/Attraction of Coherence:* PS2.B: Types of Interactions *Solar and Sidereal Time:* ESS1.B: Earth and the Solar System *Sound:* PS4.A: Wave Properties **Will depend on excerpts chosen.**