

Activity 1.2: Systems and Scale Storyline Reading Learning from the Work of Elizabeth Fulhame

What happens when ethanol burns and why does one clear liquid, ethanol, burn and another clear liquid, water, not burn? To answer these questions, you will take on the roles of questioner, investigator, and explainer. Taking on these roles will allow you to make sense of what you observed when your teacher tried to burn ethanol and water. In the unit and afterwards you can take on these roles a citizen to understand issues related to things burning. Scientists take on the same roles to explain things they see and experience in the world.

Let's see how Elizabeth Fulhame—a chemist and artist—studied how and why things burn. Fulhame was Scottish and lived in the 18th century. Aside from what she published in an essay, little is known about her life. This is because her work drew less attention than the work of male chemists. However, she had new ideas that contributed to chemists' understanding of how and why things burn. In her work, she was a questioner, investigator, and explainer.

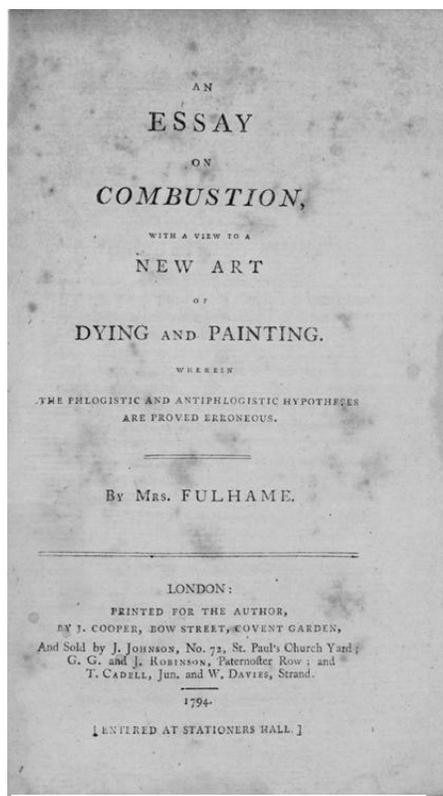
Fulhame was a questioner. She wondered if it was possible to dye fabric or paint with gold, silver, and other metals by using chemical reactions. For example, she wondered if charcoal could be used with gold to dye fabric. Each of her questions could be answered by collecting evidence.

During this unit, you will be a questioner. You will develop good scientific questions by thinking about your ideas on the Expressing Ideas Tool and through discussions with your peers. *What do you think makes a good scientific question?*

Fulhame was an investigator. Over fourteen years, she conducted a series of investigations to answer her questions. She designed the investigations based on what other scientists had already learned about similar chemical reactions from their investigations and what she was learning from hers. She documented how she conducted each investigation and the results. *Why was it important for Fulhame to document her investigations?*

During the unit, you will be an investigator. You'll make predictions and then collect evidence to help answer the questions you asked earlier in the unit. It will be important to keep notes of your predictions, your methods, and the evidence you collect on the Predictions Tool, the investigation worksheets, and the Evidence-Based Arguments Tool. Your notes will help you remember your ideas and evidence and then share ideas with your peers.

After Fulhame completed her first investigations, she had some evidence about how fabrics could be dyed using chemical reactions and how materials burn. However, her evidence left some questions unanswered, which led to more questions. She wondered if other metals would do the same thing as the ones she had tested. She wondered about what role each



Title page of Elizabeth Fulhame's
Essay, 1794 (PD-1923)

starting substance played in the chemical reaction. She described her unanswered questions in her essay so that other scientists could investigate them

The investigation you conduct will provide you with some evidence to help you answer your questions, but it may also lead to more questions or leave some questions unanswered.

Fulhame was an explainer. As scientists answer their questions, they write explanations to share with other scientists. Fulhame looked across her experiments to determine how to explain the results. Her evidence pointed towards a different explanation from what other famous scientists had proposed. As a female, she worried that her ideas would not be taken seriously. However, she explained "persuaded that we are not to be deterred from the investigation of truth by any authority however great, and that every opinion must stand or fall by its own merits, I venture with diffidence to offer mine to the world, willing to relinquish it, as soon as a more rational appears." (1794, p. xiii). For this reason, she shared her explanations in her essay. Fulhame died in the 19th century, but scientists continue to ask questions that build on her ideas. *What did Fulhame mean by her quotation above? What does this tell you about the process of science?*

When you have identified patterns in your evidence, you'll take on the role of explainer to tell a scientific story. The Explanation Tools will help you figure out how to put the pieces together in a scientific explanation. Toward the end of the unit, you'll explain how ethanol and other materials burn. Your peers will read and critique your explanations, providing feedback to help you improve your explanations.

At the end of the unit, you will be able to answer some of your initial questions about why ethanol burns and water does not. While your answers will be based on evidence and tell a scientific story, there will still be more to investigate and understand.

Elizabeth Fulhame studied combustion as a scientist, but you will need to understand combustion as a citizen in our society. Most cars have internal combustion engines—their power comes from burning gasoline inside their engines. Homes are heated by furnaces; we use flames to cook our food, and many power plants burn coal or natural gas. As you study combustion in this unit, you will prepare to understand how combustion works in all of these important settings and to use those flames wisely.

Reference

Fulhame, M. (1794). *An essay on combustion with a view to a new art of dying and painting. Wherein the phlogistic and antiphlogistic hypotheses are proven erroneous*. London: Printed for the author, by J. Cooper.