DESIGNING A BRIGHTER FUTURE

UNIT 1:

HISTORY AT THE HEART OF SCIENCE

Many scientists have devoted their lives to understanding and applying science. Their successes and failures have led to a better understanding of today's world and to new scientific advances that can benefit society.

During this activity, students will explore the importance of the history of science and ways to preserve it. The series of activities ends with a research on an artifact from the Ingenium collection that touches on the environment or energy. Broadly speaking, this unit initiates students to the study of renewable energy.

CURRICULUM CONNECTIONS

The activities in this unit can be incorporated into several different courses at the elementary and secondary levels, since the focus is on the history of science. This resource can also be introduced into history, English, and arts courses.

LEARNING OUTCOMES

- Analyze the need of history for the understanding of science
- Describe how science can be preserved
- Analyze an artifact in Ingenium's online collection
- Present research results

SUGGESTED TIME: 2 HOURS

These resources were created through a collaboration between Ingenium and a University of Ottawa doctoral candidate, Janelle Fournier.

INTRODUCTION AND BACKGROUND INFORMATION

At the Field Museum in Chicago, Carl Fuldner (an art historian) worked with Shane DuBay (an evolutionary biologist) to photograph and analyze the soot on the feathers of over 1,300 birds. The photographs illustrated the changes in the amount of carbon (soot) in the air between 1880 and 2015 in the U.S. manufacturing belt[1].

This example of an environmental change illustrates that science is not static; it evolves over time[2]. Therefore, in order to contribute to solving the current environmental and energy problems (and any other scientific problems), students need to consider the changes that have occurred in these areas of study. In order to do so, they should focus on the history of science.

Two Field Sparrows (*S. pusilla pusilla*). The bird at the top of the image dates from 1906 and the one at the bottom from 1996. Both were collected in Chicago during the spring. (Photo: Carl Fuldner and Shane DuBay)

There are, in fact, 4 major reasons why students should study the history of science:

1. **Comprehension**
   History allows students to better understand concepts as they explore the basics of science and the adaptations that have come to light over time[2] – this helps students dispel their misconceptions about science[3].
2. **Effectiveness**
   The history of science is indicative of past mistakes and failures; this is essential in order to avoid making the same mistakes and to learn from them[2]. Biologist and historian Ernst Mayr explains: "In science one learns not only by one's own mistakes but by the history of the mistakes of others"[4].
3. **Imagination**
   Thomas Edison stated that "many new ideas are simply clever adaptations of old ideas"[5]. Thus, history provides a means of preserving ideas so that students can imagine new interpretations[2].
4. **Passion**
   Students are more interested in science when they know about the lives and contributions of scientists. Thus, history can instill a motivation and a passion for science in students because they have the opportunity to get to know scientists as people who themselves have had successes and failures, but who have managed to persevere to contribute to the field[6].

Broadly speaking, the history of science enables students to learn about scientific discoveries, but also about the humanistic side of science[2].

[1] DuBay & Fuldner, 2017
[2] Maienschein, 2000
[3] Wandersee, 1986
[4] Mayr, 1982, p. 20
[5] Maienschein, 2000, p. 345
[6] Lin-Siegler et al., 2016

RECOMMENDED PROCESS

1. **Importance of the history of science**
   - Place students in small heterogeneous groups (3 to 4 students). In groups, they will be asked to analyze the importance of the history of science through reflective questions. Below are some examples of questions that can be used to facilitate this pedagogical activity. Please note that the questions should be modified according to grade levels.
     - Is the history of science important? Why?
     - Would your understanding of science be different if you did not know the history of the discipline? Give an example.
     - Do you know people (famous or not so famous) who have changed the world of science, especially in the environment and energy sectors? Try to find examples of people with different gender identities. What contributions have they made?
   - Provide portable whiteboards or large sheets of paper and markers, so students can mark their answers.
   - Ask each team to present their answers to the class.
   - Lead a discussion on the highlights that were presented, with an emphasis on the need for the history of science.
     - If the groups could not identify gender diverse individuals who have contributed to science, the environment or energy, please initiate a discussion on the importance of gender diversity in STEM (science, technology, engineering and mathematics).
     - The resources offered by Ingenium's Women in STEM site can be useful in guiding this discussion - https://womeninstem.ingeniumcanada.org/resources/.

2. **Preserving science**

   Through artifacts, we get a glimpse into the history of science.
   - Ask students to explain how we can understand the history of science and preserve science for future generations.
   - Give the following example from Ingenium's Conservation and Collection Division.
   - Explore careers that involve the preservation of science.
     - For instance, discover the various projects that fascinate the Collections and Research staff at Ingenium - https://ingeniumcanada.org/channel/boards/collections-connections?page=0

In 1987, the Conservation and Collection Services Division was established. It is responsible for the long-term care, preservation, and housing of the National Collection for Ingenium and its three museums.

Specifically, the conservation and collection services team:

- specifies and implements the correct environmental conditions for storage and display — temperature, relative humidity, light, security, and protection against airborne pollutants
- performs all treatments and interventions required to stabilize artifacts and prepare them for display or long-term storage
- documents the collection, which includes cataloguing items to museum standards, preparing written and photographic documentation, and making audio or video recordings of operational objects
- preserves the collection, providing structural supports and enclosures and managing risks such as hazardous materials or pests
- restores and operates historic working machinery

Information from Ingenium: https://ingeniumcanada.org/collection-research/conservation-and-collection-services

3. **On the hunt for an artifact**
   - Students will now have to search the Ingenium website to find an artifact related to the environment or energy. Each student should choose a unique artifact that intrigues them. Then, students will have to research this artifact to answer the questions established in class. The following are a few sample questions that could be used:
     - What is the artifact?
     - What is its use?
     - How does it relate to energy or the environment?
     - Which STEM professionals are associated with this artifact?
     - What is the connection to Canada?
     - Is this artifact still useful or in use today? Please explain.
     - Will this artifact be used in the future? Please explain.
     - Under what conditions is the artifact preserved?
     - What impact has this artifact had on our lives?
   - The artifact and related information can then be presented to the class or submitted as a report.

ADAPTING TO DIFFERENT GRADE LEVELS

The extent to which teachers undertake these activities depends on the grade level of the students. That being said, teachers may choose to modify the activity described above for students at the elementary level. For example, instead of researching an artifact from the Ingenium collection, students could bring in from home an object that they think might be in a museum some day. They could then present this environment or energy related object to their classmates by answering some of the questions cited above.

DIG DEEPER

Designing a work of art

Having researched an artifact related to the environment and energy, students could now design a work of art that could be preserved in the history of science. Works should always refer to the environment or to energy.

- For younger students, the works of art could represent how they perceive the environment in which they live. Otherwise, students could choose to create works that showcase their perceived notion of the future of the environment.
- Intermediate and secondary students could also choose to design works that visually depict the environment in the near or distant future. Alternatively, students could depict an environmental issue in their artwork. They can draw inspiration from artists such as Jitet Koestana.

.

Students could choose to use various art materials to create sculptures, paintings, drawings, or other works of art. They could also use software such as Photoshop and Illustrator to create a poster. The works should be accompanied by explanations.

Photo: Tim Arterbury

ASSESSMENT

Diagnostic

During group work, teachers can circulate to the different student groups to assess the answers to the questions asked. They could make note of the rigour of their answers, their reasoning and their critical thinking. Later, during the class discussion, educators may also note the students' knowledge of the various ways to preserve science.

Formative/Summative

The research on an environmental or energy related artifact can be assessed by a formative or summative evaluation. Educators can assess the quality and the breadth of the explanations, as well as the reasoning used to determine whether the artifact will be used in the future. Teachers could ask students to present their artifact to the class or to provide a written report. When assessing the artwork, the teacher can evaluate the can evaluate the students' critical and creative thinking.

REFERENCES

DuBay, S. G., & Fuldner, C. C. (2017). Bird specimens track 135 years of atmospheric black carbon and environmental policy. *Proceedings of the National Academy of Sciences*, *114*(43), 11321–11326. https://doi.org/10.1073/pnas.1710239114

Lin-Siegler, X., Ahn, J. N., Chen, J., Fang, F.-F. A., & Luna-Lucero, M. (2016). Even Einstein struggled: Effects of learning about great scientists' struggles on high school students' motivation to learn science. *Journal of Educational Psychology*, *108*(3), 314–328. https://doi.org/10.1037/edu0000092

Maienschein, J. (2000). Why Study History for Science? *Biology & Philosophy*, *15*(3), 339–348. https://doi.org/10.1023/A:1006733114136

Mayr, E. (1982). *The growth of biological thought: Diversity, evolution, and inheritance*. Belknap Press.

Wandersee, J. H. (1986). Can the history of science help science educators anticipate students' misconceptions? *Journal of Research in Science Teaching*, *23*(7), 581–597. https://doi.org/10.1002/tea.3660230703