Teaching the History of Science to Students with Learning Disabilities

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Many state departments of education require instruction in the history of science. For example, the state of North Carolina has established four goals or competencies in the area of science history:

1. Students should recognize the validity and importance of historic science studies.
2. Students should be able to define the vocabulary used in historic science studies and recognize how this vocabulary is similar or dissimilar to the vocabulary used today to discuss related concepts.
3. Students should understand how historic science studies relate to their lives today.
4. Students should remember general information and some specific details about the science stories they encounter from the past. (North Carolina Department of Public Instruction, 1999, pp. 50-51)

Using traditional instructional techniques to teach this material to students with learning problems can be a difficult task. However, when role-playing and multisensory experiences are incorporated into the science lesson, students become active, successful learners.

The purpose of this article is to present a lesson template designed to engage students in a specific science event from the past in a manner that relates to the students' lives and experiences. Making activities relevant to students aids in retention of science knowledge and helps promote active participation in the activity. This student-focused approach is characterized by fast-paced, student-centered, highly motivating activities that promote cognitive and affective growth. It demonstrates that instruction anchored in real-life situations promotes higher-level thinking and the development of reasoning skills (Meese, 2001). Such activities empower students with learning disabilities to achieve at a high level in science and other content area courses (Phillips, Fuchs, Fuchs, & Hamlet, 1996). Similar activities have been found to increase comprehension among students with mild cognitive and intellectual disabilities (Mastropieri & Scruggs, 2000). In addition, the guided questioning format assists them in developing inquiry skills that lay the foundation for future inquiry and can be applied throughout the curriculum. In addition to students with learning disabilities, this activity is also appropriate for students with attention-deficit/hyperactivity disorder (ADHD), allowing them to focus on class work while actively moving about the classroom engaged in the role-play (Williams & Hounshell, 1998).

The following sequence has been created to teach the vocabulary of natural selection and evolution using activities based on the landmark peppered moth study published by Kettlewell in 1973. This lesson can be implemented in regular education, inclusive education, and self-contained special education settings.

THE LESSON: SCIENCE BACKGROUND

Biston betularia, the peppered moth, has two color variations or phenotypes: black and white. Prior to 1850, the peppered moth occurred primarily in its light form: white with black spots. The black or melanic form was far

less common. However, by the early 20th century, the moth occurred primarily in its dark form--a reversal of phenotypes. In this 50-year span, during the Industrial Revolution, the trees in the cities in England became darkened by soot deposits. Thus, the white moths could be easily seen by predators. Predatory birds, the "agents" of natural selection in our story, ate the light moths, leaving behind the black moths. Dr. Kettlewell devised the landmark study theorizing industrial melanism in moths in 1973. In this study, Dr. Kettlewell released dark and light moths in two areas, one industrial and one rural. He found that the moths that survived and that were recovered later in the industrial area were dark colored. In the rural area, light colored moths prevailed.

PREPARATION: ACCOMMODATING DIVERSE LEARNERS

This lesson combines a reading-based approach with other modalities to compensate for lower reading comprehension levels. By keeping the reading short (assigning individual parts or roles) and assigning it in advance, students have time to learn and practice their parts. This removes the stress associated with--if not the difficulty of--reading and allows all students to take part in the class activity, thus providing an opportunity for building self-esteem. In the activity, various approaches may be used to capitalize on the diverse learning styles of the students. For example, students may read or recite their parts of the script, listen to other students practice their parts of the scripts, prepare props and exhibits, move to their places and act out their parts, and write a front-page story about the trial. In an inclusive classroom, rather than excluding the students with disabilities from this activity or asking them to take a more passive role, we assign them tasks that build on their areas of strength. Teachers are able to teach in a primarily visual-auditory mode while students can learn in any or all of the four modalities. The activities also allow teachers to achieve the four main goals (previously mentioned) of historic science teaching.

ACTIVITY A: HYPOTHESIS TESTING

For every group of four students, obtain four pieces of construction paper, two dark and two light. Cut or hole punch 100 circles from one piece of dark and one piece of light paper. Place these circles on the opposite colored paper. Show the papers to the students, and have the students predict the difficulty level for a fly-by predator, such as a bird, to eat the pieces since they clearly stand out from the background. Next, place the same number of the same colored circles on the papers (both dark and light pieces on the light and dark paper). Allow the students to predict how successful predation would be now, as compared to the prior condition.

To illustrate these scenarios, have a student be the predator for 3 seconds. The student can stand near the paper with the mixed colors and "eat" circles with tweezers. Count the number of circles of each color the student has "eaten." Explain that the "eaten" circles represent dead organisms, and evolution can no longer occur. The remaining population has changed, however. There are now more circles of one color (most likely the same color as the paper). This activity helps students grasp the theory that evolution and natural selection act on a population rather than an individual and that organisms with the most advantageous adaptations are the ones that are more likely to survive given environmental pressures.

ACTIVITY B: HISTORICAL ROLE-PLAY

Assign roles for the students to play. Students will need some time to read the materials and create costumes or at least some individual identification props. You will need to create Exhibits A and B. On the day of the play, arrange the room to resemble a courtroom. Students not employed as actors will take the role of court reporter. Conduct the trial, following the script. While the jury is deliberating, but before the jury delivers its verdict, each of the remaining students should write down their own verdict and an accompanying statement supporting their decision. When the jury gives its verdict, the other students can compare their answers. Next, pair each cast member with a court reporter. Court reporters should interview cast members and write a front-page news story about the trial. At this time, key terms (evolution, natural selection, agents of natural selection, adaptation) can be placed on the board. These terms should be included in everyone's front-page story.

ASSESSMENT

The reporters' stories can be used for assessing their knowledge of the material. We assess these stories using a rubric like the one in Table 1. Each category assessed can be weighted differently for each student depending on the needs of the student at the time. This allows students to practice learning strategies and rewards students for their efforts on individual levels. Rubrics can also be developed to measure the knowledge and skills displayed by other participants and cast members.

SUMMARY

Historical science activities provide opportunities for students to relate to science and to realize that science is something that they can do and understand. According to the American Association for the Advancement of Science (1990), when teachers provide students with historical perspectives when teaching science, they also

[help] students to become aware that women and minorities have made significant contributions in spite barriers put in their way by society; that the roots of science, mathematics, and technology go back to early Egyptian, Greek, Arabic, and Chinese cultures; and that scientists bring to their work the values and prejudices of the cultures in which they live. (p. 202)

Thus, as teachers of inclusive or special education, immerse your students in science. Let them have fun. And, most of all, remember that a little background about the subject helps all students relate to, enjoy, and, ultimately, understand the subject. The sidebar provides a 4-step procedure to help plan additional science lessons incorporating this historical approach.
ADDED MATERIAL

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Table 1. Sample Assessment Rubric

Grade	Criteria/check list
A	Exceptional (quality, not quantity...goes beyond expectations)
	____ Use of all terms
	____ Inclusion of major points
	____ Verdict reported
B	Very Good (superior quality in meeting expectations)
	____ Use of all terms
	____ Inclusion of most major points
	____ Verdict reported
C	Acceptable (quality is satisfactory, what you would consider average)

____ Use of some terms
____ Some major points included
____ Verdict not reported

D/F Unacceptable (quality does not meet expectations--must redo)

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INSTRUCTIONAL SEQUENCE FOR SCIENCE HISTORY LESSON

1. Provide students with historical and scientific background information. (This can be done in a variety of ways: by reading a short story to them, a multimedia presentation, a short lecture, or even recruiting a speaker.)
2. Introduce activities to the students.
3. Have students participate in the activities and conduct formative assessment as appropriate.
4. Assess the activities summatively; provide time for student input about their experiences with the activity.

THE DISAPPEARANCE OF THE PEPPERED MOTH

Cast Members: Moderator
Judge
Mr. History
Mr. Coal
Ms. Industry
Ms. Ecology
Mr. Citizen
Dr. Kettlewell
The Jury (as many students as seem appropriate)
Jury Spokesperson

Moderator: This is a trial created to represent the study of the peppered moth in England. Dr. Kettlewell did not publish his study until 1973, but the changes in the peppered moth population began in the 1800s. Please take out a piece of paper and a pencil. The judge will preside over the trial.

Judge: The case before us today is the Disappearance of the Peppered Moth. The plaintiffs are Ms. Ecology and Mr. Citizen, and the defendants are Mr. Coal and Ms. Industry. Mr. History will give us the background.

Mr. History: Peppered moths are small moths found in England. Before the Industrial Revolution, most of the peppered moths were white with black spots; very few were black. During the Industrial Revolution the moth population changed colors. The population by 1900 was predominantly black. The question before us is, "Where did the white moths go, and who or what caused them to disappear?"

Judge: Mr. Coal to the stand.

Mr. Coal: For the record, it is not my fault the moths have disappeared. My company has tried to protect the

forests and its animals. It's not like we eat them for breakfast!

Judge: Let the jury decide for themselves, Mr. Coal. Submit to the questioning please. What kind of business do you run?

Mr. Coal: I melt steel in a coal-fired plant. My plants produce the highest quality steel goods in England. We heat the steel in giant fires fueled by coal.

Judge: Is it true, Mr. Coal, that coal fires produce a great deal of smut and can cause air pollution?

Mr. Coal: There is a lot of smoke from the fires, but we are completely within the air quality guidelines.

Judge: Thank you very much, Mr. Coal. You may step down. Ms. Industry, will you please take the stand? Please explain the state of industry in the 1700s and 1800s.

Ms. Industry: Certainly. Most industrial plants, of any sort, used coal to heat or fuel their fires during the beginnings of the Industrial Revolution. Most private homes used coal to heat and cook food! England did not have any pollution controls for air or water at that time. Mr. Coal was completely in compliance with all of England's environmental regulations at the time.

Judge: Thank you, Ms. Industry. Ms. Ecology, can you please take the stand now?

Ms. Ecology: Several years ago, the white peppered moths were found all over our birch trees. Our birds ate and sang well. When Mr. Coal came to the area, the trees turned dark. The moths stayed for a few years, but then they disappeared. Mr. Coal harmed these moths.

Judge: Please let the jury decide for themselves. Mr. Citizen, can you please state your case?

Mr. Citizen: The people of the area have noticed a decline in white peppered moths. As their representative, I am here to find out why the moths disappeared and how to bring them back. The decline was not noticed until 1885. But, by 1900, we didn't see any of the white moths. The decline did seem to start when Mr. Coal's business boomed.

Judge: Again, the jury needs just the facts. I would like to all Dr. Kettlewell to the stand.

Dr. Kettlewell: Thank you, Judge. I have been studying the peppered moth for several years. I, too, noticed a decline in the population of white moths, especially near the cities. But I also noticed a rise in the black moth's population in these same urban areas.

Ms. Ecology: Objection! The fate of the black moths is of no importance to this case.

Dr. Kettlewell: On the contrary, the fate of the black moths is the fate of the white moths. Both moths belong to the same species, Biston betularia. Before the Industrial Revolution, the trees were white and so were the majority of the moths. See Exhibit A. As you can see here, the white moths blend into the background, which in this case is the birch tree. The few black moths were easily seen and thus easily eaten by birds. In this way natural selection--the mechanism by which organisms with more favorable traits are "selected for" by nature...can lead to increased adaptation to the environment--drove the population toward a lighter color. When the Industrial Revolution was in full swing, the trees darkened. See Exhibit B. The birds were able to see and eat the white moths then. And as an agent of natural selection, the birds helped drive the population toward a darker color.

Judge: Thank you, Dr. Kettlewell. In your opinion, did the Industrial Revolution and Mr. Coal cause the disappearance of the peppered moth?

Dr. Kettlewell: They did not cause the moths to disappear. The moths are present in their black form. But the Industrial Revolution and Mr. Coal did cause the trees to darken, which contributed to the change in the moth's population.

Judge: Thank you, Dr. Kettlewell. Are there any more statements to be made? No. Then Jury, your charge is to deliberate these questions: Did Mr. Coal's actions cause the decline of the peppered moth? Did his actions change the outcome of the natural selection process?

Moderator: [To the class] While the jury makes its decision, please take your sheet of paper and make your decision. Write down the reasons why you believe the defendant is guilty or not.

[Pause until this has been accomplished.]

Judge: Will the jury spokesperson please deliver the verdict.

Jury spokesperson: The jury has found Mr. Coal not guilty on the first count. He did not cause the decline of the peppered moths. The jury has found Mr. Coal guilty of actions that changed the moth's appearance.

Judge: Mr. Coal, you are guilty of potentially tampering with natural selection but not guilty of killing an animal. You will be fined and required to meet England's new environmental standards for clean air and water.

Mr. History: This case was studied almost 25 years ago. Since this time England has developed stronger clean air and water regulations, and the white form of the peppered moth has made a reappearance near cities.

Moderator: Court reporters will be able to interview one of the cast members. Each court reporter will compete for the front-page story in the national world newspaper. Court is recessed.