Virginia law. Hitler's supporters used this court ruling to support their own atrocities.

Sterilization laws existed in the U.S. till the 1970's, facilitating over 60 000 forced procedures. May 2002 was the 75th anniversary of the Supreme Court ruling in the Carrie Buck case, and at that time the state of Virginia became the first state to apologize for the sterilizations it had forced.

Source: Moore, R., Jensen, M., Hsu, L., & Hatch, J. (2003). Lessons of history: Ethics & the public's views of science & society. *The American Biology Teacher*, *65*, 85-89.

Students Enjoy Chemical Sensation

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Abstract

This exciting new way of teaching high school / college chemistry combines music, visual aids, and chemical experiments in multi-sensory lessons that motivate students and provide them with meaningful learning experiences in science. The method, known as the Chemical Sensation Project, acknowledges that some individuals learn by seeing or hearing, and others learn by actively performing activities, so it incorporates diverse learning styles to meet the needs of all students.

Introduction

Chemistry educators and researchers Dana Barry and Hideyuki Kanematsu have developed a multi-sensory approach for the teaching of chemistry (Barry, Kanematsu, Shimofuruya, & Kobayashi, 2003). Their method, known as the Chemical Sensation Project, combines music, visual aids, and chemical experiments into captivating and enjoyable science lessons (Barry, 2003). It also incorporates a variety of teaching styles to meet the needs of all students, including those with disabilities.

The project contains songs which address many topics in chemistry, a sketch / visual aid to accompany each song, two chemical experiments to complement each song, and evaluation forms, which provide both students' and instructors' reactions to the program and learning results. These materials were prepared by Dana Barry and translated into Japanese by Hideyuki Kanematsu. Tatsumasa Kobayashi and Hiroshi Shimofuruya, Suzuka National College of Technology, Japan also provided

assistance. The program is sponsored by the Northern New York Section of the American Chemical Society and by Suzuka National College of Technology.

The program's chemistry songs (titled "Organic Chemistry," "Acid Verses Base," "Chemicals," "Matter and Energy," "Fission and Fusion," "Science Is," and "Periodic Table") (Barry, 1996) were included in the popular science education television series *Sensational Science*, which aired in New York State in 1996-1997. These songs and their complementary chemical experiments cover many topics in chemistry. Science activity titles include "Hydrocarbons," "Functional Groups," "pH and Indicators," "Acids and Bases," "Chemicals," "Bonds," "Half-Life," "Helium and other Gases," "Cooking," "Walking," "Mixtures," "Surface Tension," "The Human Atom," and "Periodic Table of Items" (Kanematsu, Shimofuruya, Barry, & Kobayashi, 2002). These activities will be included in a science book to be written by the authors of this article.

Participants begin the Chemical Sensation program by viewing a picture/visual aid and the words to a selected chemistry song, while listening to the song. The words to the songs are written on handouts and overhead transparencies. They then perform the exciting chemical experiments. Finally, they answer chemistry questions related to the activity and complete the evaluation forms.

An Example Lesson

The following multi-sensory lesson complements a high school chemistry unit on bonding. The students begin by singing the song "Chemical Bonds" to the tune of "My Bonnie." In addition, they view a three-dimensional model of sodium chloride or a picture displaying different bond types. The class then performs the enjoyable bonding activity, which provides concrete examples for the senses of seeing, touching, and so forth.

Chemical Bonds

Bonds hold things together.
They may be weak or strong.
Energy is released when they form.

The sharing of electrons,
forms bonds,
covalent bonds.

The attraction of ions forms bonds,
ionic bonds,
ionic bonds.

Oh, bonds hold things together.

Bonds

Question

How are chemicals held together?

Information

A chemical is held together by a bond. Covalent bonds are made by the sharing of electrons. Ionic bonds are made by the attraction of oppositely charged ions (charged atoms), such as in sodium chloride (table salt).

Activity

Simulate the stretching of bonds. You will need the following materials: a metric ruler, a cotton ball, a small rubber band, a caramel or gummy candy, a piece of gum, and any other items provided to test. Please record all data on a separate sheet of paper.

First measure and record the length of each item in its original form. Then stretch each item up to its breaking point (i.e., till it just breaks). Measure the length of each stretched item and record it. Identify the item that stretches the most.

Extension

1. Simulate an ionic bond using two magnets. Let the magnets represent oppositely charged ions. *Hint:* Opposite poles of a magnet attract and like poles repel.

Use a magnifying glass to closely examine some table salt (sodium chloride), a chemical with ionic bonds. In this chemical, the sodium is a positive ion and the chlorine is a negative ion. Record your observations. Next add one teaspoon of table salt to a paper cup filled with water and stir. What happens? Why?

2. Make models of compounds such as methane (CH_4) and ethene (C_2H_4). Refer to chemistry reference tables and books containing structure / bond information for assistance. Use chemistry model kits or gumdrop candy of different colors and toothpicks. Let black gumdrops represent carbon and white ones be hydrogen. Use the toothpicks to simulate covalent bonds. Keep in mind that methane (natural gas) has single covalent bonds whereas ethene (a gas also known as ethylene) has a double bond.

Evaluation

The Chemical Sensation Project has been successfully carried out at Clarkson University, Edwards-Knox High School, and Canton High School in the United States and at Suzuka National College of Technology, Takada High School, and Kanbe High School in Japan. Students using the multi-sensory approach learned chemistry. After each lesson, they were required to answer questions, which were developed to provide educational feedback about the program. For the student participants in the U.S., 94% of the Canton High School students, 100% of the Edwards-Knox High School students, and 100% of the Clarkson University students answered the questions correctly.

Students in the United States and Japan enjoyed learning chemistry through the project. They gave the program's theme (the combined use of chemical experiments / activities and songs) a good rating. The evaluation results of Table 1 show that students found the theme creative and pleasing. A "neutral reaction" in our study refers to one in which the student has a feeling of indifference. A "very positive reaction," for example, is one in which the student thinks the approach is great. The other possible extreme reaction is "very negative." This would indicate to us that the student did not like the song or activity.

Table 1
Student Reactions to the Combined use of Chemistry Activities and Songs

Organization	Number of students	Category of reaction			
		Creative		Positive	
		Very creative reactions (%)	Neutral reactions (%)	Very positive reactions (%)	Neutral responses (%)
Clarkson University (US)	28	89	4	82	14
Edwards-Knox High School (US)	20	95	0	95	5
Canton High School (US)	21	81	14	76	14
Total for three US organizations	69	88	6	85	11
Suzuka National College of Technology, Japan	47	72	14	71	23
Takada High School, Japan	56	84	16	82	11
Kanbe High School, Japan	39	72	23	79	13
Total for three Japanese organizations	142	76	18	77	16
Total for both US and Japanese organizations	211	82	12	81	13

In addition, of the high school student participants in the U.S. (Canton High School and Edwards-Knox High School), 86% had a neutral or very positive reaction to the songs and 93% of them had a neutral-very positive reaction to the activities. Of the Japanese high school student participants (Takada High School and Kanbe High School), 88% had a neutral-very positive reaction to the songs and 92% of them had a neutral-very positive reaction to the activities. Of all college student participants (Clarkson University, U.S. & Suzuka National College of Technology, Japan), 79% had a neutral-very positive reaction to the songs and 99% of them had a neutral-very positive reaction to the activities.

In addition to the students, the instructors and administrators hold this program in high esteem. The instructors said that the chemical experiments were exciting, useful, and meaningful to the students. They liked the music component and believed it to be educational, entertaining, and relaxing. Mr. Goto, Principal of Kanbe High School, Japan said that the music component of the program is a great idea. He believes that the songs relax the students and prepare them for the exciting activities in chemistry. Mr. Jeffrey Davis, Principal of Edwards-Knox High School (US) said the program works well and that its multi-sensory approach is a fascinating concept.

References

Barry, D. M. (Composer). (1996). *Chemical sensation with the Barry Tones* [CD]. New York: Author. (This CD may be purchased, for USD 8 plus handling and shipping, by contacting Dana Barry at dmbarry@clarkson.edu .)

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Demonstration

While the activities in this section of *SER* have been designated demonstrations, they might easily be structured as hands-on student learning experiences. While some sample lesson sequences have been included, the notes provided both here and in the following *Student Experiments* section are meant to act primarily as stimuli for classroom activities and to provide teachers with background information, so please modify any sample pedagogy as you see fit.

The Rocket Principle

Needed. Balloon, cardboard shoe box (the removable lid is not needed), scissors, and wooden dowel.