A Semiquantitative Method for the Study of Air Pollutant Mixtures

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The envelope of pollution that encompasses a significant portion of our country, particularly the urban areas, is a source of growing national concern. All of us need to increase our understanding of the sources, the components, and the physiological and environmental effects of air pollution. This is particularly true of the youth in our schools. They should be made aware of the complexity of air pollution, the social costs and the plausibility of various abatement procedures since it is the generation of people now in the schools who will bear the major burden of the improvement of environment quality just as the actions of the previous two generations have contributed much to the present environmental crisis.

Simple, but dramatic experiments often increase the environmental awareness of secondary school students. An experiment of this type using Ringelmann charts is described in this article. Ringelmann charts have been used for a number of years as a method of quantifying air pollution. In recent times, they have largely been replaced by more sophisticated techniques (Batton, 1966), e.g., computers are used to count and size particles suspended in the air. However, the simplicity of the Ringelmann technique makes it highly adaptable for teaching purposes. Powers' Microringelmann charts are available for $.35 each from McGraw-Hill Publishing Co., Inc.

The Microringelmann chart is about 3" x 5". Two sets of grids are on the chart; one set is below a ½"-wide slot; the other set is above it. The grids are numbered from one to four; number one is the least dense (dark) and four is black. By using the chart, the observer can rate the density or darkness of the smoke emitted from a smoke stack.

The classic procedure for the use of the Microringelmann chart is as follows: A suitable site for smoke emission is selected; usually this is a smoke stack of an industry or a power plant. The observer stands at least 100 feet from the stack and not more than a quarter of a mile from it; he holds the Microringelmann chart with the grids facing him and at arm’s length; he makes several observations of the smoke at one minute intervals, determines the Ringelmann number for each observation and calculates the average “number” for the observations.

Students should note the climatological conditions, e.g., time of day, air speed and wind direction. Students may also wish to ascertain the major sources of smoke and what type of combustion processes are involved, e.g.,
soft coal burned by a power plant is a common source of air pollution in many communities. This investigation may stimulate the students to determine some of the probable components of the smoke—the gases and aerosols present. Another logical extension of the study is to initiate a discussion with the plant owners and local pollution control officials about some of the possible abatement procedures. This is a natural introduction to class projects which consider the effect of a local industry on environmental quality. These studies could include social, economic and political factors, in addition to the scientific principles involved.

Another potential use of the Powers' Microringelmann charts is to compare the amount of particles suspended in the air in various locations. A suction pump or a vacuum cleaner may be used to draw air through filter paper; the amount of soiling (darkness) of the filter paper can be rated by using the Microringelmann technique (N.B. a photometric estimate can be made, but the procedure is more complex.) This simple procedure allows for a comparison of the amount of particles suspended in air in various parts of a community: such as an area near an industrial complex, in the school yard, in the classroom, in a suburban residential area and in the open country.

A simulation procedure will allow students to rate the density (darkness) of an air pollutant mixture within the confines of the classroom. A gallon jar is a convenient container; it is large enough to allow students to view the mixtures at distances up to 10 feet. This allows several students to observe the particular mixture at the same time. The pollutant mixtures should be prepared under a chemical fume hood. After the mixture is initiated, a lid should be placed on the jar to prevent the spread of the smoke throughout the classroom.

A series of jars may be prepared to represent various air pollutant mixtures. A chemical mixture of ammonium hydroxide and hydrochloric acid produces a white-colored smoke (ammonium chloride); a reaction of copper strips and nitric acid produces nitrogen dioxide, a brown gas—a common pollutant produced by automobile and industrial combustion processes. A small pyrex beaker can be placed inside the gallon jar to house the reactant mixture. Other reactant mixtures that can be ignited to illustrate the pollutant potential of combustion processes include dried leaves, pieces of soft wood or a small amount of motor oil. A small can can be placed in the gallon jar as a container for these substances. A piece of asbestos, placed under the can, acts as an insulator and prevents cracking of the base of the gallon jar. A number of air pollutant mixtures may be used, but the instructor should closely supervise their preparation.

This simulation allows the student to use the Microringelmann technique, i.e., to rate the density of various smoke mixtures. It can be an effective preface and a motivating device for studies of environmental quality in the community. It is convenient; it can be set up in the classroom with a minimum of effort and materials; the results are readily analyzable.
In this age of ecology, there is a need to develop an acute sense of environmental awareness in young people. In this connection, there is a need for educational materials and experiments that can be effectively and easily used in the science classroom at the pre-college level. I hope that experiments like the one described in this article will make a small contribution to that effort.

BIBLIOGRAPHY
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**Two-Billion-Year-Old Algae**

Fossil evidence that blue-green algae much like those that exist today existed as much as two billion years ago has been found on a knoll near Eveleth, Minnesota. Blue-green algae are among the world's most primitive organisms; they are not much more advanced than the most primitive bacteria. Yet the Eveleth samples appear to be very similar to the blue-green algae that help clog today's eutrophying ponds. They are among the world's earliest identifiable life forms, and the Minnesota fossils, says Dr. Preston Cloud, a biogeologist at the University of California at Santa Barbara, are the oldest demonstrable examples yet found.

The Minnesota fossils appear to be "slightly older—probably not more than a few million or tens of millions of years," than now-famous Gunflint microfossils from the north shore of Lake Superior, the oldest that could up to now be confidently identified, says Dr. Cloud.

"But the real significance is not the age," says Dr. Cloud, whose research is supported by the National Science Foundation and the National Aeronautics and Space Administration. "They are not all that much older than the Gunflint fossils."

In contrast to the Gunflint microfossils, however, the fact that they are readily separable from the rock deposits in which they occur permits a comparison with living organisms with a precision and detail not heretofore possible.

If, thanks to fine detail like that seen in these fossils from the Pokegama strata in Minnesota, evolutionary changes can be detected in blue-green algae, he suggests, then perhaps they can be used to identify the relative ages of strata in which they are found.

Older microfossils have been reported, says Dr. Cloud, going back some 3.2 billion years or more. But he feels that those are still open to scientific question; the Pokegama and Gunflint fossils, he says, are the oldest ones that can be called relics of early life with 100 percent certainty.