1 / VOL. 3, NO. 1
THE CHEMICAL EDUCATOR

ISSN 1430-4171
http://journals.springer-ny.com/chedr
10.1007/s00897980175a

Of Special Interest

Report On "Water Chemistry: Using Field and Laboratory Experiences to Teach Scientific-Thinking Skills"

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The analysis of the data can easily be modified to be appropriate for any level of students….

The workshop participants were led through the water chemistry laboratory by Susan Kegley. The format of the workshop was in the form of a site visit to a local housing project to study the water quality. Workshop participants scouted the site for suitable water-sampling locations, determined which of the locations to sample, and then sampled the water at those locations. Discussions of the group focused on how this water module could be adapted by schools other than the University of California at Berkeley. Descriptions of the suitability of the

"Water Chemistry: Using Field and Laboratory Experiences to Teach Scientific-Thinking Skills" by Susan Kegley was presented at the "Day 2 to 40" workshop symposium held May 10–11, 1997. The two-day event was held in the Willard H. Dow Chemical Sciences laboratory building on the central campus of The University of Michigan in Ann Arbor, Michigan. Each of the articles that comprise this issue was written by one of the group of reporters whom I asked to attend each session to take field notes and then follow up with the session leader and participants afterwards.

—Brian P. Coppola, Proceedings Editor

ISSN 1430-4171
http://journals.springer-ny.com/chedr

S 1430-4171 (98) 01175-X

water chemistry module for adoption were also discussed, and included material from the well-written manuals for both students and instructors.

Chronology

1. The group met and left the Chemistry building to take a bus to the site. On the bus we discussed practical considerations for coordinating a laboratory field trip.

2. The group arrived at the site and Susan led a discussion on how to lead students to correctly scout a site.

3. The group broke into 3 small groups to scout the site and make observations.

4. At the end of the scouting, all the groups collected and reported what they had discovered. Susan then led a discussion of where water samples should be collected at the site.

5. The usage of field meters (pH, conductivity, dissolved O2) was demonstrated by group members under the direction of Susan. The meters were calibrated for use at this time also.

6. The small groups acted as students and took water samples and collected measurements.

Report

There were two monologs in this workshop. The first was a description of the background of this water chemistry laboratory module, the second discussed the actual collection of the data.

Background

Although the lab was designed for the University of California at Berkeley, it is flexible enough to use at smaller schools with fewer students and smaller budgets. The level of students that have used this module ranges from high school to an undergraduate analytical laboratory. A convenient feature of this module is that Susan Kegley has written a comprehensive instructor’s manual as well a student laboratory manual. A school lacking the resources of the University of California could perform

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the laboratory using only inexpensive equipment (pH paper, standard titrations, and balances) and students would still receive many of the laboratory's benefits: creating a plan (as a class); learning the techniques; sampling local waters; and learning about fieldwork, data analysis, and statistics.

This laboratory module is designed to occupy from 3–4 weeks in a semester-long class. UC Berkeley uses four modules per semester. Unusual materials and equipment are listed (along with price, source, and catalogue number) in the instructor's manual. All of the experimental procedures are also elaborated in detail in the instructor's manual so that there is a ready reference for unfamiliar techniques.

Actual Water Collection Techniques

The most important part of a successful laboratory experience is the planning of the trip. When an instructor is searching for a site to sample, they must have an eye for detail. The site should have room for a walking range of about 20 minutes and a convenient area for parking a car (or bus). It is important that the water being sampled be expected to show some differences. For example, a stream near a housing development is an excellent choice because the class can study the effects of the development on water quality. Susan pointed out that the best local source of information for promising sites is a local geologist. A map of the site should also be secured before the student's field trip.

Before leaving with the students on the day of the trip, along with providing each student with two maps (one of the water and one of the surrounding areas), a prelaboratory lecture should focus on s*ignposting*. Signposting means telling the students what is at the site, what they are going to do, why they are going there, and why they should care. The student goals for the laboratory are written in the manual. Susan likes to remind the students that no one (not even the instructor) knows what the "right" answer will be concerning the water quality—this is a true collaboration!

When preparing to leave for the site, the instructor's must make sure all the required instruments are packed. Susan gave a list of other things that should be packed in addition to scientific equipment. This includes life jackets, first-aid kit, snake-bite kit, change of dry clothes, sunscreen, bug repellent, extra plastic bags for notebooks, extra hats, and extra gloves. Students should also be warned about possible local dangers (poison ivy and poison oak in California).

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When the students have arrived at the site Susan likes to give another signposting before beginning the walk-around. Some interesting places that students can find to collect a sample are: near vegetation, drain lines, water sources, water sinks, and by rocks. The students are also reminded that they should write details about the collection areas in the notebook that they are carrying. Data suggested by our group included current weather conditions, wind, water flow, a description of the site, and previous weather.

After the sites are determined through a class discussion, the functions of the meters (pH, conductivity, and dissolved O_2) are described by Susan, and students are drafted to practice under her watchful eye. The calibration of the meters is then performed by the students before they sample the water. One important point is to make sure that all the bottles have labels that are permanent—water soluble markings are disasters waiting to happen. The labeled bottles (each with one unique number) are then handed to the students and they take the bottles to the site to fill. The students record the measurements taken with the meters at the same place they fill the bottles and record the bottle number on the map where the sample was taken.

When the students return from the site visit the instructor should post a map of the sites in the laboratory with the collection points the water samples marked in colored ink. The students can do a fecal coliform bacteria test (instructions are in the student laboratory and instructor's manual) to obtain information about the bacterial count of the water. A simple and inexpensive technique developed by Susan for keeping the bacteria samples warm is to seal the samples in a ziplock bag and submerge the bag (using a brick for weight) in warm water.

The data analysis for the samples can be completed by students as a part of their laboratory reports. Samples of the appropriate data analysis are in the instructor's manual, and a complete tutorial for the students is given in the student's manual.

Dialog

Many parts of this laboratory were dependent on dialog between the instructor (Susan) and the students (the workshop participants). Questions asked by Susan at the site, such as "What are you going to look for when scouting for a good site?" were open for the input from the group. At our site (a creek near a new housing division) the group decided to look for standing water, vegetation areas, rocks, and drainage lines. Other

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groups could have arrived at different places to look at and different things to look for, but the group shaping the laboratory experience is an integral part of this Water Chemistry module.

Other questions leading to a decision by group dialog were: “What are you going to write about in your notebooks?” and “What sites will you sample?” The answers to these questions as given by the students shape the laboratory experience for everyone.

Because the workshop participants were also teachers, there was also a great deal of dialog at the teacher-to-teacher level with Susan. One of the early discussions dealt with how to get students to write in the notebook. One of the participants felt that many times students don’t want to write something “wrong,” and so don’t write anything at all. Suggestions from others in the group included: showing an actual notebook used by the instructor, praising a student who is doing a good job of writing everything down, and just telling the students to treat this as a learning experience—so don’t worry about getting everything perfect.

One of the more interesting dialog periods occurred when the workshop was split into subgroups to scout the area for good water sampling locations. Each subgroup was isolated from the others as they explored, and so they had to make decisions about what was important to write down independently. Each group ended up drawing a sketch map localizing features that could be seen from a distance (a big rock here, a big tree there, a bridge, etc.) although no mention of this was made to the workshop as a whole, and each participant was given a map from the housing division. Each group also described the water with respect to color and movement.

The groups did naturally record different things. One subgroup measured the speed of the stream by dropping a twig into the stream and measuring the time it took to travel 5 paces. Another subgroup noticed an odd dandelion pattern, where the dandelions ended abruptly exactly where the golf course began, and wanted to test the nearby water for pesticides and fertilizers. Another noticed an algae area so active that the water was bubbling. Each group became an expert on the area in which they took the most interest.

When the subgroups recombined to decide what areas should be sampled, all the observations were discussed. This was an example of how important it is for the

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groups to separate and explore. The workshop as a whole was able to sample more interesting areas than any single group found independently.

Adoptive Participation

This lab module is tailor made for adoptive use. The manual for the students is over 150 pages packed with information. It includes an introduction to laboratory safety, laboratory procedures and goals, and a tutorial of Microsoft excel for data analysis. The text is clearly written and good illustrations are sprinkled throughout.

The manual for instructors is 115 pages and ready for classroom use. It covers the preparation for doing this module; all the experimental equipment and techniques; and even has grading suggestions, handouts for students, and overhead masters. This is a well-executed idea for a portable laboratory module.

Adaptive Participation

Several possible adaptations were mentioned in the workshop for use outside the University of California. The expensive equipment that they use can be substituted with less expensive alternatives (pH paper for the portable field pH meter) or even eliminated (the dissolved O_2 meter). The size of the groups has been small (such as the workshop of seven people) or large (such as the 1300-student, 50-teaching-assistant groups of the Berkeley classes). The analysis of the data can easily be modified to be appropriate for any level of students (from a sophomore analytical chemistry class to a high school chemistry class).

The water could be brought from the student’s homes if a field trip is a barrier. In this case the laboratory could center around the potability of drinking water. In cold climates snow could be collected and analyzed (Susan pointed out that there is no bad weather, just bad clothing!). A yearly statistical picture of the drinking water or water sources could be collected and recorded.

After considering the possibilities for adapting a water chemistry laboratory, it is hard to imagine that people live anywhere that this module could not be used.

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Feedback

There was unanimous agreement from the responding participants that the written materials (two manuals and site map) were both appropriate and useful both for the workshop and any future use. Several workshop participants indicated that they planned to adapt the water chemistry laboratory for their classes during the next year. The plans for adaptation include a supplementary high school (Saturday) class, a freshman general chemistry class, and a college environmental chemistry class.

Several participants did not know that we were taking a site trip, and wished that the need to dress for outdoor activities was listed in the workshop description. The one common complaint was that the portion of time taken by outdoor activities was too high. Several participants felt that some of the time taken at the site could have been best spent discussing student problems and how to best approach the statistical analysis.

One feedback comment was not directed at this workshop in particular, but workshops similar to this. The question of how curriculum changes are reviewed, and who they are reviewed by was not discussed—even though such questions are vital to the acceptance of modules such as this. The respondent pointed out that for many schools to contemplate changes in their curriculum these questions must be answered before the changes will be approved.

The overall feedback from this workshop was overwhelmingly positive.

Workshop Participants

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