Water Quality Techniques and Analysis: Teaching Activities for Philippine Schools and Communities*

Merle C. Tan and Elma A. Tamura
National Institute for Science and Mathematics Education Development, University of the Philippines, Diliman, Quezon City. Philippines

Introduction

Water bodies are sources of water for domestic, agricultural and industrial activities, habitat for a diverse flora and fauna and are therefore major sources of food and livelihood, and used to transport people and goods, for recreation, for electricity generation, and even for waste disposal. Furthermore, they help moderate the climate.

The Philippines is surrounded by water. About 65 percent of Filipinos live in coastal areas. The scenic lakes are tourist attractions and supply water to many towns and cities. More than 300 river systems connect towns and people. Unfortunately, most of the water bodies are at different levels of pollution. Human activities contribute largely to the problem, reducing the quality and usefulness of these water resources.

Safeguarding the quality of water resources as well as protecting and conserving the biodiversity of living organisms are major challenges to local and national governments. It is important to equip citizens with water quality monitoring skills so that they can participate in protecting and managing the water resources.

The formal school has a big role to play in developing the skills in managing water resources. Students should be exposed to activities that will help them develop these skills so that they can share their knowledge and skills with their family members and friends. However, current textbooks and student manuals in basic education contain minimal activities along this area. Most teachers are not familiar with these skills because they were not given the training during their college days.

The National Institute for Science and Mathematics Education Development (NISMED) conducts training of classroom teachers and teacher trainers. One of the training programs spearheaded by the High School Earth/ Environmental Science Education Workgroup (HSES) is on water quality monitoring. The content of the training is based on the results of the Riverwatch Project started in 1997 under the Science and Mathematics Education Manpower Development Project (SMEMDP) funded by the Government of Japan through JICA.

This paper describes the experiential learning that NISMED staff underwent while conducting the Riverwatch Project and the objectives, activities and outputs of the training program on water quality monitoring.

The Riverwatch Project

The major objective of this community-based project involved the monitoring of the physical, biological and chemical characteristics of the river near the University. The Riverwatch Team was made up of science education researchers and specialist from NISMED as well as students from the UP College of Science. JICA experts assigned in the SMEMDP served as consultants. The Local Government of Marikina, where the monitoring stations were located, gave support in terms of use of boats for monitoring and ensuring the safety of the researchers while they were conducting overnight on-site testing.

The main purpose of the project was to train our Riverwatch Team in monitoring the quality of a river so that they can pass on the skills to their trainees/participants. Because of limitation in funds and manpower,

on-site and laboratory tests were done and analyzed quarterly over two years. We realized later that our project could have made an impact if we did a more frequent observation and testing. In between our monitoring schedule, a fish kill episode occurred in the project site. The very low value for dissolved oxygen for that month was not monitored.

Despite the limitations of the project, the Riverwatch Team recognized that water quality monitoring provides many opportunities to make the school curriculum relevant and meaningful to students. The results of the tests were used to develop activities that enhance higher order thinking skills. These activities were tried out in selected schools around the river.

The Training Course

The short-term course on water quality monitoring is a continuing activity at NISMED. An 18-hour course is regularly scheduled once a year (for three Saturdays) but some commissioned training on the same topic last for 36 hours.

After the training, the participants are expected to:

use correct water sampling procedures for the different chemical, physical and biological tests;

conduct the water quality tests;

analyze/interpret the results of the water quality tests;

explain the interconnectedness of the water quality parameters using relevant science concepts; and

enhance their participation in community activities related to water quality monitoring.

The training exposes the participants to hands-on, minds-on and hearts-on activities, both on-site and in the laboratory. It also enables them to use commercial and improvised equipment.

Although the training program is prepared in advanced, an assessment of prior knowledge related to water quality monitoring is conducted to help the trainers focus on monitoring skills that need to be reviewed only and those that need to be given more time. The assessment includes a paper and pencil test to determine the participants' knowledge of terms and interconnectedness of the water quality parameters as well as a practical test where the participants are asked to identify the equipment used for the monitoring and what they are used for.

An introductory session on the properties of water is conducted to provide justification for the need to monitor a body of water. This is followed by a workshop on making a water quality slide. This slide is later used to identify benthic macro- invertebrates (insects, worms, crustaceans, mollusks and other animals visible to the naked eye) living in the substrate of the river bottom. The water quality slide is also used as an indicator of the extent of pollution of that body of water. A discussion on how to prepare for and conduct a field study is held highlighting the safety precautions that need to be observed.

Early morning of the following meeting, the participants are brought to the nearest river. They make a profile of the riparian environment to determine the erosion condition of the riverbank, the plants that thrive in the area, the stream depth and width, the sources of water pollutants, and other characteristics. The participants are then assigned stations where to do the water sampling and/or conduct the on-site testing. Activities on-site include the following: observing the odor and color of the water, identifying the kind of macroorganisms using the water quality slide, and determining the dissolved oxygen, pH, temperature, turbidity, and electrical conductivity of the water using a water quality tester. They collect water samples for the biological test (BOD and coliform) and chemical tests (COD, chlorides, nitrate, phosphorus and ammonia) which are done in the laboratory

Back in the laboratory, the participants store the water samples and are taught how to prepare the solutions needed for the different tests. In small groups, they perform the different water quality tests. A discussion of the results of the tests is done the next meeting, including the results of the 5-day BOD test and the presumptive test for coliform. The post activity discussion emphasizes the interconnectedness of the water quality parameters. The participants demonstrate their knowledge and skills when they play the ecological domino game or when they supply answers to the concept maps.

The results of the observations and tests are used to develop some student activities. This part of the training is necessary because in some schools, the equipment and chemicals may be difficult to obtain. Students can use the data to practice their analytical skills.

A post training assessment is done using the same questionnaire and checklist in the pre training assessment. Participants are also required to evaluate the course.

Some Water Quality Monitoring Activities

Making a River Profile **This activity requires the participants to observe the various types of plants in the riparian zone (the area along the banks and the verge of the river), amount of bare soil and the degree of bank damage in the area and the other materials covering the river. Participants are asked to draw what they observe using symbols in the vegetation identification key and to interpret what they observe using the riparian assessment key.** This activity helps them realize the importance of the riparian environment in maintaining the quality of the river.
Identifying Macroorganisms Using a net, the participants collect organisms in the water sediment and examine submerged rocks and logs for organisms that are attached. They determine the biodiversity using the sequential comparison index which is computed using the formula: total number of organisms divided by total number of species or runs. They also compute for the pollution tolerance index. The kind and number of living organisms found in the substrate used as indicators of water quality.
Determining the Water Quality This is the bulk of the training program. It includes testing some physical, chemical and biological parameters of the water suitable for secondary schools. A commercial multi-tester is used for the on-site testing of dissolved oxygen (DO), turbidity, pH, and electrical conductivity. The test for phosphorus, nitrates, ammonia, suspended solids, BOD, and E. coli are done in the laboratory. The results of the tests from three experimental stations are consolidated to give an overall picture of the quality of the riverwater. The results are also related to the profile of the river based on the observations of the riparian zone.
Using Onion Seedlings for Monitoring Water Contaminants This activity shows that locally available materials like onion can be used in water quality monitoring. Using root index, mitotic index, and micronuclear frequencies as indicators, participants determine the effect of different water contaminants.

Some Student Activities Based on the Riverwatch Data

Some Student Activities based on the Riverwatch Activities

Some Activities Based on the Riverwatch Results

Determining the Effect of Detergents on Fishes Detergents are commonly used at home and in washing clothes right in the river. In this activity, participants observe the behavior of fishes placed in four containers with the same amount of water but varying amounts of detergents. The activity sheet contains guide questions to help students focus their observations. The POE (predict-observe-explain) strategy is utilized in this activity. At the end of the activity, students are asked to communicate their observations through drawings and their feelings about their observations in writing.
Interpreting Graphs The results of the physical and chemical tests were presented in graphic form. Students are asked to interpret the graphs and the possible reason for the pattern observed.
Recycling Paper **One of major pollutants in rivers is solid waste. In this activity, students make paper from newspapers, old notebooks, and other kinds of waste paper. They also learn how to control some variables to standardize the resulting product.**
Using an Improvised Transparency Meter For schools that cannot afford to buy a multi-tester, some activities have to be done manually. This requires the use of improvised apparatus. To determine the depth at which sunlight can pass through, a transparency meter was developed. Water samples are collected and placed in the tube. The depth (height) of water that will allow the observer to see the cross at the base tell how far sunlight can penetrate. The observation can be used to explain the importance of light for aquatic plants under water.

Impact of the Training

The training on water quality monitoring has been going on since 1997. It is still one of the most requested short-term courses at NISMED. The Team has also been invited in radio programs to discuss the river monitoring project especially as to how it can help solve the solid waste problem.

Perhaps one indicator of success and relevance of the training is that one of the first participants from Mindanao designed a school project similar to the Riverwatch Project. Their project won an award under the Department of Science and Technology search for model community-based projects. Their prize was a trip to Japan; the teacher and some of her research students attended and shared their experiences in conducting the project in a student forum.

Future Activities

The Riverwatch Project was suspended for sometime due to lack of funds and availability of manpower, but there is a plan to do a follow up project. But the training program on water quality monitoring continues. The Department of Environment and Natural Resources has taken an interest on the training and is making plans to conduct it at the regional level as part of their activity under the Local Environmental Planning and Management Project. NISMED training staff will be actively involved in this endeavor.

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