centre de développement pédagogique

pour la formation générale en science et technologie

Training science and technology resource persons in secondary schools

"Opening the Door to Science"

TRAINING GUIDE

Problem: What is the cause of declining fish stocks and lake acidification on the north shore of the St. Lawrence River?

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Foreword

The purpose of this document is to help you conduct a learning activity on acid rain within the framework of the Québec Education Program (QEP).

This document was developed to support resource persons offering the training sessions in their school boards. It is structured chronologically to reflect the experience of the participants during the activities.

The training session allows participants to act as students so that they may understand the QEP from a different perspective. This approach should enable participants to establish connections between the reality experienced in the classroom and the theoretical concepts set forth in the QEP.

Setting aside time to reflect on the QEP, the cross-curricular competencies and the subject-specific competencies is essential in order for participants to assimilate the changes brought about by the reform.

Teachers play a vital role in helping their students develop the required competencies. Their role includes planning, targeting and limiting the number of elements that they wish to develop with their students during a given learning situation. They must also provide the tools that the students will need to record information and that will enable them to identify their weaknesses and make the most of their strengths.

The logbook used in this training session is not intended for students. Although a learning situation may serve to help students acquire a set of competencies, attitudes, techniques and strategies, if certain elements are not clearly highlighted, identified and evaluated, very few students are likely to engage in a metacognitive process essential to the development of cross-curricular and subject-specific competencies.

We have also chosen to include evaluation and regulation instruments in the training session. These will allow participants to better understand the extent of the changes to evaluation practices that have been brought about by the reform.

Broad Area of Learning Targeted by the Task

Environmental Awareness and Consumer Rights and Responsibilities

Educational Aim

To encourage students to develop an active relationship with their environment while maintaining a critical attitude toward consumption, technology development and the exploitation of the environment

Focuses of Development

- Awareness of his/her environment
- Construction of a viable environment based on sustainable development
- Awareness of social, economic and ethical aspects of consumption

Pedagogical Aim

To expose the student to a problem that will enable him/her to develop certain cross-curricular and subject-specific competencies, and to acquire knowledge of science and technology through the use of strategies, techniques and attitudes in a variety of learning activities.

Sequence of Learning Activities Related to the Problem

- Introducing the problem
- Activity 1 - Information gathering in specialist teams
- Activity 2 – Specialists' reports to the multidisciplinary teams and representation of the problem
- Activity 3 – Experiment on acidity
- Activity 4 – Demonstration of rain acidification
- Activity 5 – Designing a model and an instrument demonstrating buffering capacity
- Activity 6 – Team presentations
- Overall analysis of the learning situation

Analysis of the Learning Situation with Respect to the QEP

This section of the document shows how the learning situation is analyzed throughout the training session. Sequential analysis enables participants to reflect on the elements of the QEP and thereby deepen their understanding of them.

WORKSHOP SCHEDULE

Day 1

Duration	Activity
30 minutes	Welcome, objectives and schedule of activities
30 minutes	Definition of the problem and work organization
60 minutes	Information-gathering in specialist teams
	Break
75 minutes	Specialists' reports – representation of the problem
	Lunch
15 minutes	Analysis activity
75 minutes	Experiment on acidity
	Break
15 minutes	Demonstration of rain acidification
15 minutes	Analysis activity

Day 2

Duration	Activity
180 minutes	Designing an instrument and model
	Lunch
15 minutes	Analysis activity
30 minutes	Team presentations
15 minutes	Analysis activity
75 minutes	Overall analysis of the learning situation
	Questions and comments

Definition of the problem:

- Describing the situation
- Organizing the work
- Defining the problem (with the entire group)

NOTE TO THE FACILITATOR:

Brainstorming can be used to develop a concept map and determine the information to be gathered. Below is an example of what a concept map might look like after it has been **developed with the participants.** (Results will vary).

Example:

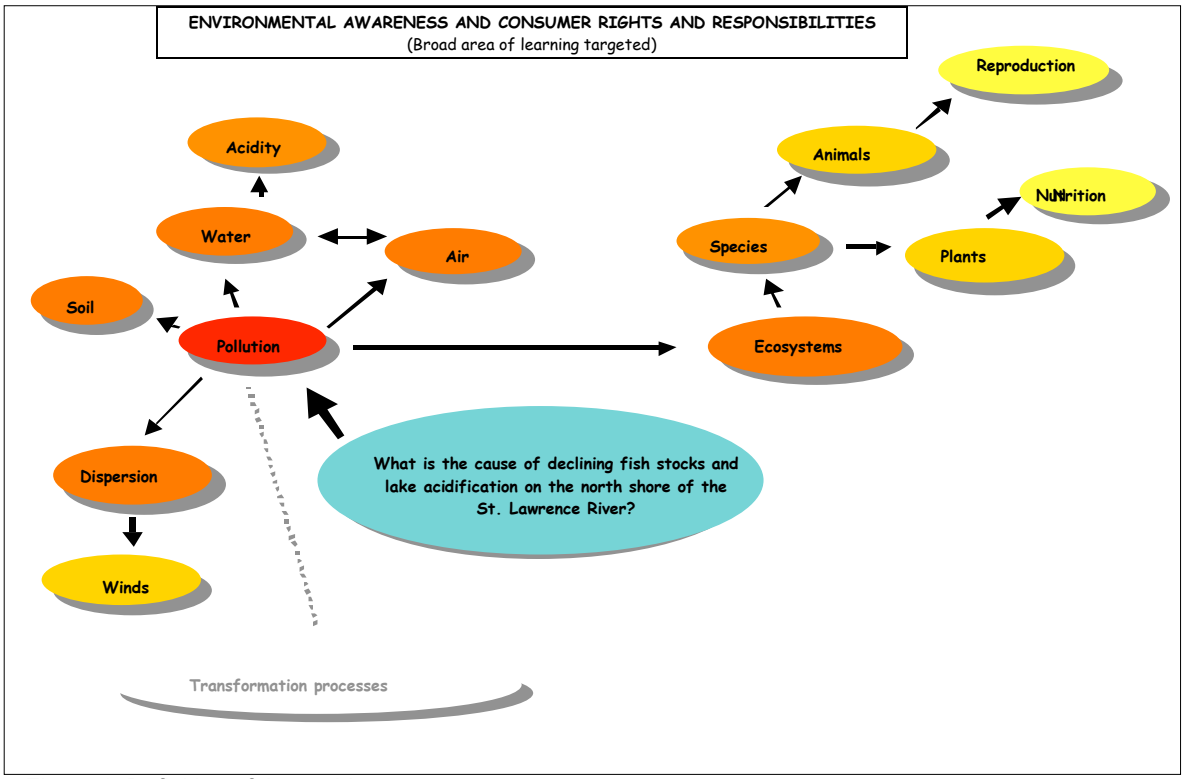

Figure 1. Definition of the problem

Cross-curricular competency developed: Solves problems

Subject-specific competency developed: Seeks answers or solutions to scientific or technological problems

Duration: 30 minutes

Material needed: Logbook (page 3), transparencies and felt pens

Description of the activity:

1. Read the context and problem with the participants.

2. At the beginning of the activity, explain what the presentations will consist of: giving an oral presentation, putting together a display kiosk, etc.

3. When forming teams, encourage the participants to choose roles that will enable them to develop competencies they do not already possess. This will place each participant in the role of student.

4. Question the participants to help them determine what areas they will need to research to fulfill their mandates.

5. Allow the participants ten minutes or so to select a name for their teams and to discuss their perceptions of the problem.

6. Using a transparency, design a concept map that will define the problem and illustrate the participants' first impressions. (Your concept map may differ from the example provided).

7. Guide the questioning in order to bring out aspects of the problem that may have been omitted.

8. Keep the concept map in order to return to it at the end of the activities.

Activity 1 - Information gathering in specialist teams

NOTE TO THE FACILITATOR:

At the end of the information search, during a group discussion, question the teams in order to identify the research strategies used and assess their effectiveness. Guide the questions so that the participants become aware of their attitudes in the teams (e.g. leadership, confrontation of viewpoints, organization of work).

Cross-curricular competencies developed: Uses information; adopts effective work methods; cooperates with others

Subject-specific competency developed: Communicates in the languages used in science and technology

Strategies, techniques and attitudes: Identifying the constraints and elements that must be taken into account to solve the problem

Duration: 60 minutes

Materials needed: Documentation from each specialty: hydrology, meteorology, geology and biology (ecology). Prepare a folder containing one copy of each document for every specialist.

For example, for four multidisciplinary teams of four specialists each (i.e. sixteen participants), prepare four folders on *hydrology,* four folders on *geology*, four folders on *meteorology* and four folders on *biology*.

Participants may consult the *Information Documents* that accompany this guide as well as textbooks used in Ecology, Physical Science 214 and Geography 314.

A bibliographic and Internet search may also be conducted instead of using these documents.

Description of the activity:

1. Read the instructions on pages 3 and 4 of the logbook with the group and provide any necessary explanations.

2. Make sure all of the specialists record the information they gather in their logbooks.

3. Set a time limit for the information search and insist that the specialist teams respect it. This will encourage them to adopt effective research strategies.

4. Remind the participants to cite their sources on the information sheets, whether they use the *Information Documents* or conduct a bibliographic or Internet search.

5. If a team is incomplete, ask a specialist from another team to provide the missing information.

6. Inform the participants that specific requirements for the presentations will be provided at a later stage (e.g. display kiosk, model, instrument demonstrating buffering capacity, explanatory text, oral presentation).

Activity 2 – Specialists' reports to the multidisciplinary teams and representation of the problem

NOTE TO THE FACILITATOR:

At the end of the activity, provide an example of how the problem can be represented. The teams may choose various formats to represent the problem, such as schematic diagrams, flow charts, text diagrams.

Example:

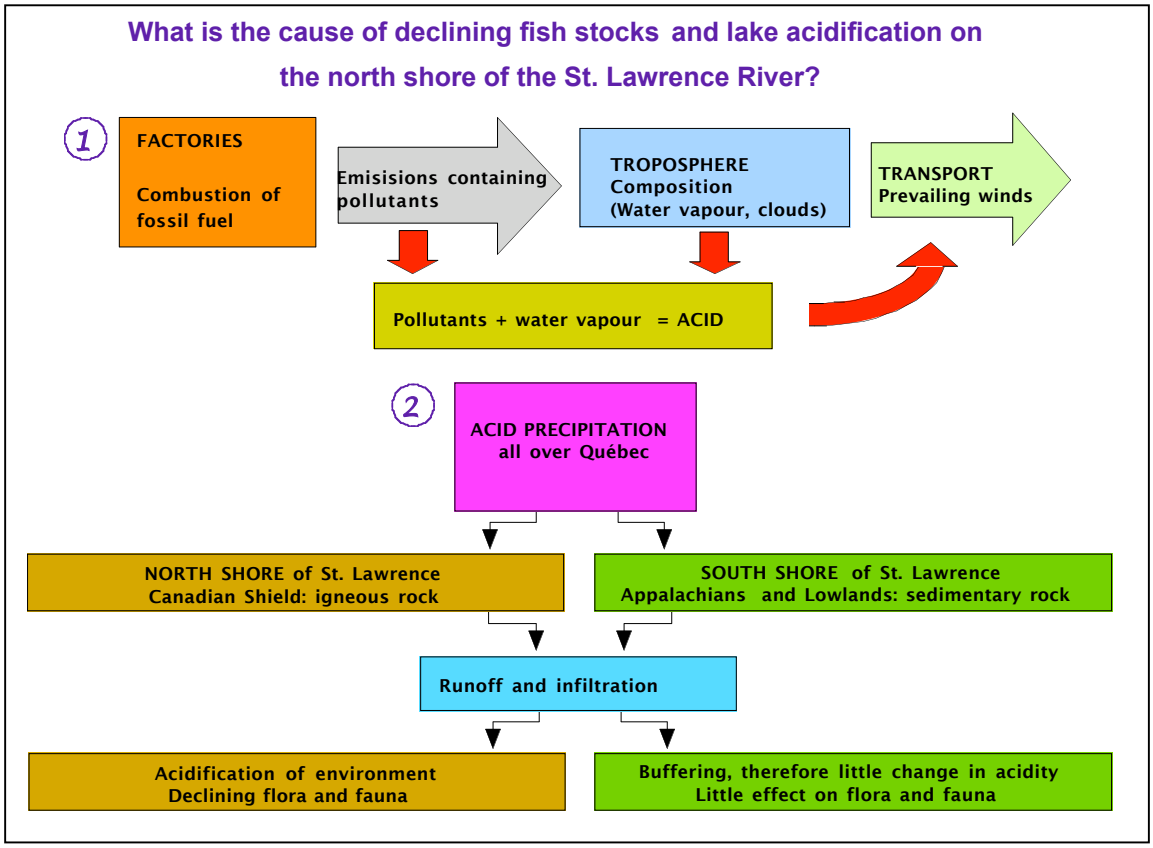

Figure 2. Representation of the problem

At the end of the activity, use an example such as the one on the next page to show that all specialists can further develop their understanding of acidity by designing an experiment.

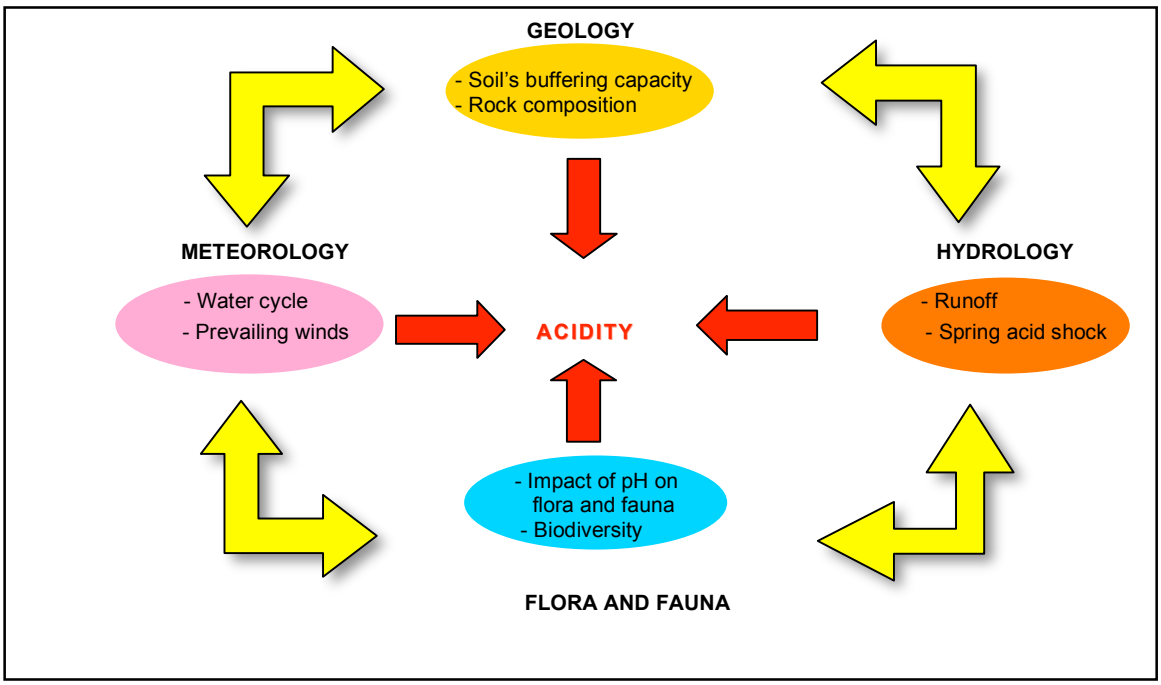

Figure 3. Concept of acidity at the heart of the problem

Cross-curricular competencies developed: Adopts effective work methods; cooperates with others

Subject-specific competency developed: Makes the most of his/her knowledge of science and technology

Strategies, techniques and attitudes: Identifying the constraints and elements that must be taken into account to solve the problem

Duration: 75 minutes

Materials required:
Sheets/cards for recording information in each discipline, colouring pencils, 11'' x 17'' paper for representing the problem, or any other useful material if participants choose other means to record information

Description of the activity:

1. Make sure all team members record their information in their logbooks.

2. Remind participants to cite their sources on the information sheets.

3. Insist that the specialist teams observe the time limit so they adopt effective information-sharing strategies. Allow the participants time to reflect on the strategies adopted by their teams and to assess and comment on the strategies of others. (This may be done orally or in writing.)

4. Have the multidisciplinary teams review the initial question and representation of the problem in order to help them fulfill their mandates.

5. At the end of the information search, during a group discussion, ask the teams to highlight the research strategies used and assess their effectiveness. In order to make participants aware of their attitudes toward their teams, have them complete the assessment forms and review the answers with the entire group.

6. At the very end of the activity, check that each has a good understanding of the buffering capacity of soil.

7. Introduce the concept of acidity and pH scales. (Pages 19 and 20 of the logbook.)

Activity 3 – Experiment on acidity

NOTE TO THE FACILITATOR:

Begin by explaining briefly why pH scales are used and what is meant by acidity, alkalinity and neutrality. This explanation serves two purposes: it places participants in the role of student and serves as a review for those who haven't studied the concepts in a few years.

Example of an explanation:

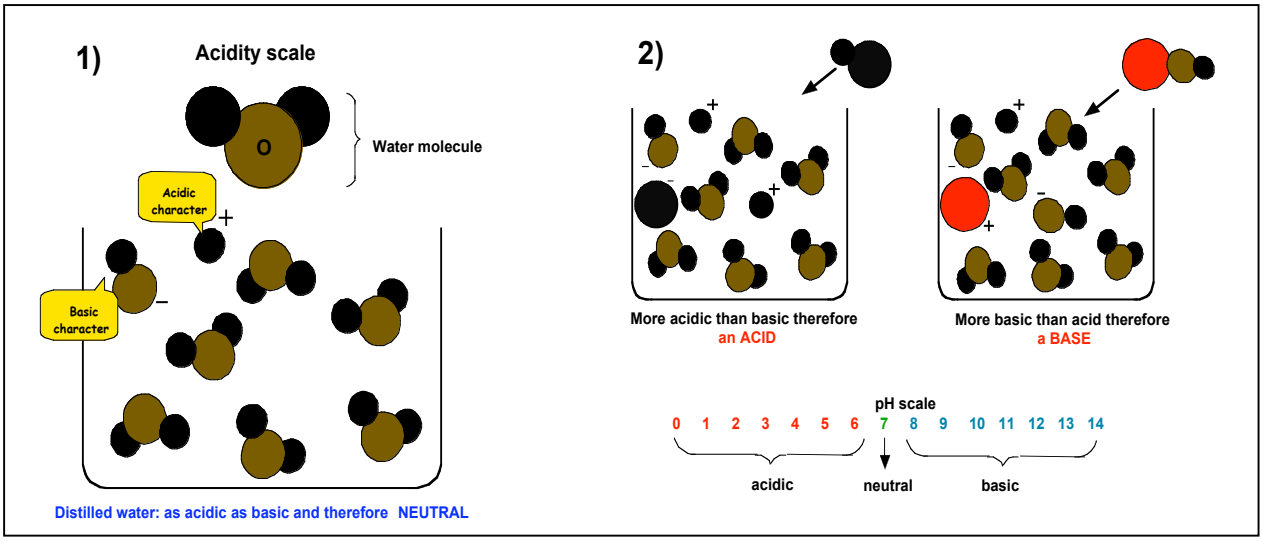

Figure 4. Acids, bases and pH scale

Cross-curricular competencies developed: Solves problems; communicates appropriately

Subject-specific competencies developed: Seeks answers or solutions to scientific or technological problems; communicates in the languages used in science and technology

Strategies, techniques and attitudes: Identifying the constraints and elements that must be taken into account to solve the problem; ensuring the procedure is appropriate and safe and making the necessary adjustments; using different tools for recording information; using laboratory materials and equipment safely; willingness to work hard; willingness to cooperate effectively with others

Duration: 75 minutes

Materials needed:

Document:
- Logbook or lab report style guide

Laboratory materials:
- Titration plate or ice tray
- Dropper
- Test tubes and test tube rack

Products:
- Buffer solutions (pH 2 to 12)
- Acid rain (melted snow or sulphuric acid solution, pH 3 to 4)
- Igneous rock (sand)
- Sedimentary rock (sand mixed with a bit of Portland cement)
- Red cabbage juice
- Household products:
  1. distilled water
  2. sodium bicarbonate (baking soda) solution
  3. window cleaner (colourless *Windex*)
  4. carbonated drink (colourless)
  5. vinegar
  6. lemon juice
  7. milk
  8. melted snow (acid rain)
  9. liquid laundry detergent (regular formula)
  10. liquid laundry detergent (sensitive skin formula)

Description of the activity:

1. Present the activity to the group. Explain briefly that there are two complementary tasks to be accomplished in the laboratory: to design a reference scale, and to verify the buffering capacity of soil samples using this scale. Each team should describe the procedure followed.

2. Remind the participants that when they carry out the activity with their students, the students will need to have their lab procedures validated by a teacher or technician before they can proceed with their experiments.

3. During the activity, make a note of some of the strategies adopted by certain teams in order to discuss them with the group at the end of the experiment.

4. Emphasize the difference in pH between regular laundry detergent (pH 10 or 11) and detergent for sensitive skin (pH 7) to promote the discussion.

5. Review the pH of milk (roughly 6.5); many people believe it to be a base.

6. Highlight the method used (i.e. designing a colorimetric scale to determine the pH of a solution) and mention other applications (e.g. pool test kits).

Activity 4 – Demonstration of rain acidification

NOTE TO THE FACILITATOR:

Certain participants may feel that conventional teaching methods should be abolished completely. Rather than relegate them to the past, teaching methods should be varied in order to reflect the many learning styles of students. By way of example, show the animation on acid rain available in French at:

<www.cslaval.qc.ca/cdp/animations.html>

Set up the following experiment:

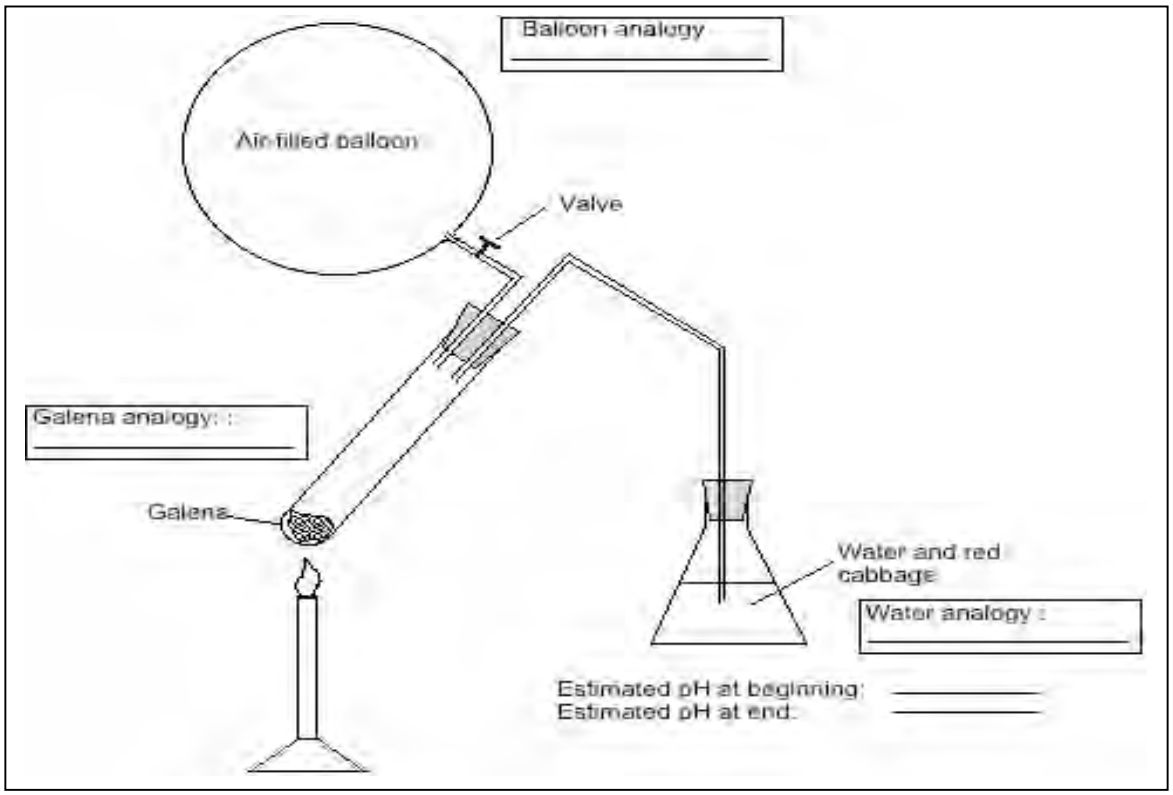

Figure 5. Setup for acid rain experiment

We suggest that you work with a universal indicator rather than with red cabbage. The range of colours is easier to read: it goes from green to orange between pH 7 and 3-4.

Open the valve carefully so as to create a slight, continuous draft toward the Erlenmeyer flask.

As soon as you turn on the burner, the galena (PbS) releases sulphur (S), which in turn reacts with the oxygen in the air to form SO_2 and then SO_3. This gas reacts with water (H_2O) to form sulphuric acid (H_2SO_4).

A blowtorch may be used instead of a burner if you do not have access to a room with a gas supply.

Subject-specific competencies developed: Makes the most of his/her knowledge of science and technology

Strategies, techniques and attitudes: Dividing a complex problem into simpler subproblems; using different tools for recording information

Duration: 15 minutes

Materials needed: Setup as illustrated, safety goggles and lab coats

Description of the activity:

1. During a discussion on the pH of rain, help participants identify the main stages in acid rain formation.

2. Draw a diagram on the board illustrating how acid rain is formed.

3. Introduce the lab setup and draw analogies between the components of the setup and the real world.

4. Allow the participants time to record their observations in their logbooks.

5. Some participants may have difficulty seeing the parallels between the lab setup and the situation in the real world.

6. Show the animation mentioned above. It illustrates the same concepts as the lab demonstration.

Activity 5 – Designing a model and an instrument demonstrating buffering capacity

NOTE TO THE FACILITATOR:

We suggest using at least two types of presentations in order to break the monotony (e.g. science-fair display booth and an oral presentation with visual aid).

Cross-curricular competencies developed: Uses creativity; adopts effective work methods; cooperates with others

Subject-specific competencies developed: Seeks answers or solutions to scientific or technological problems; makes the most of his/her knowledge of science and technology

Strategies, techniques and attitudes: Identifying the constraints and elements that must be taken into account to solve the problem; exploring various ways of solving the problem; ensuring the procedure is appropriate and safe, and making the necessary adjustments; using different tools for recording information; drawing schematic diagrams; using laboratory materials and equipment safely; team spirit; receptivity to original solutions; willingness to work hard; concern for a job well done; willingness to cooperate effectively with others

Duration: 180 minutes

Materials needed:

Documents: Specifications for the model and instrument

Tools:

- scissors, pliers
- X-Acto knife
- electric screwdriver, bits
- hot glue gun
- saws and mitre boxes

Materials:

- empty water bottles (500 mL)
- Styrofoam containers (various sizes)
- cardboard
- foam core panels
- craft foam
- construction paper
- transparencies
- plastic, paper or Styrofoam cups
- cotton balls
- cheesecloth
- tulle
- filter papers
- hot glue, white glue, glue sticks, rubber cement
- straws
- pipe cleaners
- Popsicle sticks
- skewers
- wood or metal rods (various sizes), studs
- elastic bands, string
- felt pens, colouring pencils

Products/Substances:

- pH indicator (red cabbage juice)
- acid rain (sulphuric acid, pH 3 to 4)
- sand (igneous rock)
- sand mixed with a bit of Portland cement (sedimentary rock)

Description of the activity:

1. Clearly explain the format of the presentations and the instructions to follow.

2. Distribute the design specifications for the model and instrument. Allow the participants a few minutes to look at them.

3. Quickly go over the specifications with the group and review the requirements for the schematic diagrams. Remind the participants to record all information in the logbooks: how they came up with ideas, assessed solutions, produced the schematic diagrams and built the model or instrument.

4. Inform participants that they are not allowed to use adhesive tape of any kind and emphasize the need to produce high-quality work.

5. Provide an example of a diagram.

6. Some participants may be overwhelmed by the amount of work they need to accomplish in a short period of time. If that is the case, emphasize that the work must be divided up and shared among the team members.

7. Present the materials to be used.

8. Observe and take notes on the various strategies adopted by the teams in order to discuss them during the analysis of the learning situation.

Activity 6 – Team presentations

NOTE TO THE FACILITATOR:

Encourage the participants to diversify their presentations in order to sustain the group's interest. The sole purpose of the presentations is to make the participants aware of the wealth and diversity of solutions put forth by the group in spite of the time constraints.

Cross-curricular competencies developed: Cooperates with others; communicates appropriately

Subject-specific competencies developed: Communicates in the languages used in science and technology

Strategies, techniques and attitudes: Using various means of communication; attentiveness; team spirit; willingness to cooperate effectively with others

Duration: 30 minutes

Materials needed: Support for posters or display elements, video projector and screen, formative evaluation checklist for the models and instruments (included in the documentation)

Description of the activity:

1. Allow each team approximately five minutes for their presentation.

2. Have the teams give their presentations one at a time.

Analysis of the learning situation with respect to the QEP

NOTE TO THE FACILITATOR:

There are four different instances during the training session when it is advisable to take the participants out of their role as students and allow them time to reflect on and establish connections between what is suggested in the QEP and what the students experience in the classroom. Otherwise some participants may feel that the task was designed without any thought to the QEP or may not have enough time to fully grasp the QEP concepts.

Four 15-minutes periods have therefore been set aside to analyze the learning situation. Please make sure you have a projector or transparencies for these activities.

The first activity consists in associating each task listed on the first slide with the corresponding cross-curricular or subject-specific competency. In order to sustain the participants' interest and to keep to the schedule, neither the subject-specific content, nor the strategies, techniques and attitudes have been included in the activity. However, they will be included in the overall analysis activity at the end of the training session.

Some statements may fit into more than one category or may spark discussion between participants, depending on their interpretation. This will only enrich the discussion.

At the end of the activity, slides 2 and 3 may be shown.

Discussion starter for Activity 1:

Activity 1 - Definition of the problem, information gathering, information sharing, and representation of the problem

- ***Understands the causes and environmental issues involving industry and recognizes the importance of mastering a variety of scientific and technological concepts in order to define the problem.***
- ***Searches for information during a specialist meeting and summarizes this information on worksheets.***
- ***Cites information sources and validates sources by comparing them.***
- ***Searches for information in a committee of experts and identifies elements of the solution in order to develop an overview of the problem.***
- ***Chooses a format (e.g. text, flow chart) to represent the problem and compares his/her solution to that of peers. Working with the group, understands the problem and tackles it by searching for information.***
- ***Seeks a consensus on the information to retain.***
- ***Records all information in his/her logbook.***
- ***Respects the deadline.***
- ***Understands how acid rain is formed and how species evolve as a result of increased acidity in the environment.***
- ***Shares tasks with teammates and appreciates the quantity of information processed.***

Statements classified according to QEP competencies

Activity 1 - Definition of the problem, information gathering, information sharing, and representation of the problem

Cross-Curricular Competencies

Adopts effective work methods

- *Working with the group, understands the problem and tackles it by searching for information.*
- *Seeks a consensus on the information to retain.*
- *Records all information in his/her logbook.*
- *Respects the deadline.*

Uses information

- *Searches for information during a specialist meeting and summarizes this information on worksheets.*
- *Cites information sources and validates sources by comparing them.*

Cooperates with others

- *Shares tasks with teammates and appreciates the quantity of information processed.*

Activity 1 - Definition of the problem, information gathering, information sharing, and representation of the problem

Subject-Specific Competencies

Seeks answers or solutions to scientific or technological problems

- *Searches for information in a committee of experts and identifies elements of the solution in order to develop an overview of the problem.*
- *Chooses a format (e.g. text, flow chart) to represent the problem and compares his/her solution to that of peers.*

Makes the most of his/her knowledge of science and technology

- *Understands the causes and environmental issues involving industry and understands the importance of mastering a variety of scientific and technological concepts in order to define the problem.*
- *Understands how acid rain is formed and how species evolve as a result of increased acidity in the environment.*

Discussion starter for Activity 2:

Activity 2 - Experiment on acidity, demonstration of rain acidification

- ***Respects the conventions for writing lab reports.***
- ***Presents his/her data according to established standards.***
- ***Keeps a record of the procedure followed in his/her logbook.***
- ***Chooses a scenario for laboratory investigation.***
- ***Explains acid rain formation using a simulation.***
- ***Designs an experiment to determine the pH of household products and verify buffering capacity.***
- ***Respects the time limit.***
- ***Uses a model to explain and understand a large-scale phenomenon.***
- ***Compares his/her approach to that of peers.***
- ***Writes a lab report according to suggested guidelines.***

Statements classified according to QEP competencies

Activity 2 - Experiment on acidity, demonstration of rain acidification

Cross-Curricular Competencies

Solves problems
- ***Designs an experiment to determine the pH of household products and verify buffering capacity.***

Adopts effective work methods
- ***Respects the time limit.***
- ***Keeps a record of the procedure followed in his/her logbook.***
- ***Uses a model to explain and understand a large-scale phenomenon.***

Communicates appropriately
- ***Respects the conventions for writing lab reports.***
- ***Presents his/her data according to established standards.***

Statements classified according to QEP competencies (cont.)

Activity 2 - Experiment on acidity, demonstration of rain acidification

Subject-Specific Competencies

Seeks answers or solutions to scientific or technological problems

- ***Chooses a scenario for laboratory investigation.***
- ***Compares his/her approach to that of peers.***

Makes the most of his/her knowledge of science and technology

- ***Explains acid rain formation using a simulation.***

Communicates in the languages used in science and technology

- ***Writes a lab report according to suggested guidelines.***

Discussion starter for Activity 3:

Activity 3 - Designing an instrument, a model and presentation elements

- ***Divides up the tasks to be accomplished according to the strengths of each team member.***
- ***Comes up with various ideas and chooses a concept for each presentation element.***
- ***Develops the model, instrument and presentation elements.***
- ***Evaluates his/her solutions in relation to the specifications.***
- ***Keeps a record of all of his/her design ideas and evaluates them in relation to the specifications.***
- ***Observes the conventions for schematic and construction diagrams.***
- ***Selects the information to convey in the model and visual aids.***
- ***Designs a model and an instrument demonstrating buffering capacity.***

Statements classified according to QEP competencies

Activity 3 – Designing an instrument, a model and presentation elements

Cross-Curricular Competencies

Uses information
- ***Selects the information to convey in the model and visual aids.***

Uses creativity
- ***Designs a model and an instrument demonstrating buffering capacity.***

Adopts effective work methods
- ***Keeps a record of all of his/her design ideas and evaluates them in relation to the specifications.***

Cooperates with others
- ***Divides up the tasks to be accomplished according to the strengths of each team member.***

Activity 3 - Designing an instrument, a model and presentation elements

Subject-Specific Competencies

Seeks answers or solutions to scientific or technological problems
- ***Develops the model, instrument and presentation elements.***
- ***Comes up with various ideas and chooses a concept for each presentation element.***
- ***Evaluates his/her solutions in relation to the specifications.***

Makes the most of his/her knowledge of science and technology
- ***Develops the model, instrument and presentation elements.***

Communicates in the languages used in science and technology
- ***Observes the conventions for schematic and construction diagrams.***

Discussion starter for Activity 4:

Activity 4 - Peer presentations

- ***Explains how acid precipitation is transported from its source to a given ecosystem.***
- ***Makes a presentation in front of his/her peers, answers questions and compares his/her understanding of a phenomenon with that of others.***
- ***Explains the causes of acid precipitation.***
- ***Presents orally all of the information gathered during the information search and in the laboratory, using terminology specific to science and technology.***
- ***Assigns presentation tasks according to the strengths of each team member.***
- ***Chooses the necessary tools to support the discussion.***

Statements classified according to QEP competencies

Activity 4 - Peer presentations

Cross-Curricular Competencies

Cooperates with others
- ***Assigns presentation tasks according to the strengths of each team member***

Communicates appropriately
- ***Chooses the necessary tools to support the discussion.***

Statements classified according to QEP competencies (cont.)

Activity 4 - Peer presentations

Subject-Specific Competencies

Makes the most of his/her knowledge of science and technology

- ***Explains the causes of acid precipitation.***
- ***Explains how acid precipitation is transported from its source to a given ecosystem.***

Communicates in the languages used in science and technology

- ***Presents orally all of the information gathered during the information search and in the laboratory, using terminology specific to science and technology.***
- ***Makes a presentation in front of his/her peers, answers questions and compares his/her understanding of a phenomenon with that of others.***

Overall analysis of the learning situation

At the very end of the workshop, the participants are asked to do an in-depth analysis of the connections that exist between the QEP and the activities experienced.

During the sequential analysis, a large part of the QEP was set aside in order to lighten the task and to bring to the fore the cross-curricular and subject-specific competencies.

The participants are now asked to consider the Science and Technology program as a whole. They should highlight all of the concepts, strategies, techniques and attitudes that are brought out during the learning situation.

The facilitator is free to choose how to conduct this analysis. There are many tools developed in various milieux with which the facilitator and participants are familiar. The analysis may also be guided by questionnaire or checklist.

It is preferable to ask the participants to work in groups of four and produce a report at the end of the activity. This helps promote discussion and enables the participants to confront and validate their understanding of the competencies, QEP content, cultural references and the philosophy behind the QEP.