Utilizing Local Environmental Issues in Developing Critical Thinking Among High School Students

Lea Cabauatan-Garcia

Case studies of six second year public high school students were conducted to determine the significant improvement in the students' thinking skills after analysis and discussion of local environmental issues, describe the thinking processes that the students employed before and after class discussion on the topics, and identify the teaching strategies most useful in analyzing environmental issues. A pretest-posttest instrument with three to four open-ended questions on four local environmental issues was administered to the students, with interviews to verify their analysis. Intervention strategies used in class discussions were issue analysis, lecture discussion, small group discussion, concept mapping, film showing, role playing, and a combination of film showing and small group discussion. Results reveal that critical thinking abilities indeed improved when the students analyzed local environmental issues. They used different critical thinking skills, along Freedman's model of critical thinking strategies. Improvement was noted in the posttest as more concepts, ideas and reasons were observed in the students' analysis. The most useful teaching strategies was role playing. This was followed by a combination of film showing and small group discussion.

The objectives of Environmental Education are set towards acquiring knowledge, attitudes, skills and values about, and for, the environment (Asian Development Bank 1999; Braus 1995). The Department of Education (DepEd, then Department of Education, Culture and Sports or DECS) and the Department of Environment and Natural Resources–Environment Management Bureau (DENR-EMB) have identified specific values and skills concerning the environment that should be developed among Filipino learners in the secondary level. These include logical comprehension, emotional attachment, responsibility, moral reasoning and various thinking skills such as intuitive thinking, analytical thinking, hypothesis testing, problem solving, and critical thinking. In other words, recent trends in science education focus on higher order thinking skills.

But even before the release of the Environmental Education Guide prepared by DENR-EMB and DECS in 1999, learners were already being taught the skills of observing, describing, distinguishing, classifying, inferring, explaining, analyzing, deducting, designing, and assessing. However, no studies have been made on how these thinking skills are developed, demonstrated and observed in an Environmental Science class, although studies have been recorded for other subject areas. Hence, the researcher aimed to find out if critical thinking skills can indeed be developed among high school students using local environmental issues.

Critical Thinking

Presseisen (1987) identifies the higher order thinking skills as problem solving, decision making, and critical and creative thinking. She reports that students use problem solving to resolve a known difficulty by gathering and putting together facts about the difficulty, decision-making in choosing the best response given several options, and critical thinking in analyzing arguments and generating insights into particular meanings and interpretation resulting in logical reasoning patterns.

A number of authors believe that critical thinking has something to do with reasoning. For one, Siegel (in Hernandez 1991) says that a critical thinker is one who is appropriately moved by reasons. He has a propensity or disposition to believe and act in accordance with reason and has the ability to assess the force of reason. Schrag (in Hernandez 1991) believes that most creative intellectual work occurs in logic which is almost synonymous with critical thinking. Norris, et al. (1989) further say that critical thinking is reasonable thinking that is focused on deciding what to believe in and what to do.

Lauren Resnick (in Hernandez 1991) describes critical thinking as non-algorithmic and complex since it involves nuance judgment, application of multiple criteria, and uncertainty. It also requires self-regulation of the thinking process and imposing meaning (finding structure in apparent disorder). Edward de Bono (in Hernandez 1991) distinguishes between vertical and lateral thinking, adding that lateral thinking has many attributes which are associated with critical thinking.

Moore (1992) suggests that an Environmental Science class should teach students to synthesize information and think critically. This involves

not merely imparting a set of "facts"; students must be encouraged to ask and answer questions such as "Why do I believe this?" and "What is the evidence for this?" Likewise, they must be encouraged to make corrections by answering "How does this relate to other facts and principles?" Critical thinking should be stressed not only inside the classroom but also outside of it because lack of critical thinking has important consequences that extend far beyond the classroom. Moore warns that unless teachers show the students that critical thinking is valuable outside the science classroom, a large part of the population will continue to confuse science and pseudo-science. Norris (1989) fully agrees with Moore and emphasizes the importance of critical thinking in success and survival: "There is no basis for assuming that critical thinking instruction in school subjects will automatically transfer to everyday life, so critical thinking must sometimes be evaluated in everyday-life contexts."

Strategies to Develop Critical Thinking

A variety of strategies can be utilized to develop and improve critical thinking skills in students. One common strategy is issue analysis. An environmental issue can be analyzed and investigated by selecting the issue, clarifying the nature of the issue, researching and analyzing the various viewpoints, evaluating alternative viewpoints and their implications, and investigating possible solutions to the problem (Asian Development Bank 1999). Allen (1987) assigned the students to read six or seven short science news articles, contemplate on one or two hypothetical claims posed by the instructor, and a week later, take a short quiz made up of questions selected from the list. His study revealed that science news articles helped and improved the students' ability to compose a concise, logically persuasive line of reasoning on why a claim should be either conditionally accepted or not accepted.

Another strategy is the use of small group discussions which Allen also tried in Physics. His study showed that small discussion classes facilitate a detailed verbalization of the thought process during problem solving with special attention to pursuing the consequences of incorrect theories and models. Another study in Biology (Allen 1987) showed that class/lecture discussion is effective in analyzing specific problems because Biology focuses on basic concepts and processes of scientific investigation. Allen concluded that student activities such as writing, critiquing and revising arguments and using many reasoning patterns encourage students to think critically. Frequent feedback from teachers allow students to quickly recognize and correct their mistakes.

Concept mapping has also been considered as a widely used and acknowledged teaching method in Biology, Geomorphology, Chemistry, and Physics and research and development (Hoz 1997; Primo 1996; Domin 1996). This teaching technique has been found useful in revealing cognitive structure, displaying the complexity of relationship, organizing knowledge, enhancing both instruction and learning, providing an amusement instrument for student's misconception, and serving diagnostic purposes. Concept maps of different students may vary, but they all serve to express the students' creative and critical thinking.

Another effective technique is role playing which Cherif (1995) describes as one that provides an opportunity for "acting out" conflicts, collecting information about social issues, learning to take on the roles of others, and improving students' social skills. Asian Development Bank (1997) defines role playing as on-the-spot "acting out" of a situation, problem or incident which is used to focus a group discussion around some concrete experiences. Joyce and Weil (in Cherif 1995) emphasize that role playing plays an indispensable part in human development and offers a unique opportunity for resolving interpersonal and social dilemmas.

Ornstein (1990) believes that film is the most influential and seductive educational medium for transmitting ideas and persuading an audience to a point of view. Because of the vivid, often larger-than-life images it presents, the motion picture has a dramatic impact on its audience.

Studies also show that the types of examination or test greatly influence the higher order thinking skills of students (Allen 1987; Crow 1989a; Moore 1992; Gigliotti 1994). Crow (1989) opines that testing and teaching should go hand in hand and that if a student is given tests for only recall of content, all the teaching of critical thinking is wasted. Thus, to enhance the critical thinking abilities of students, open-ended questioning about an issue should be asked during a test. Some of the skills that are associated with open-ended questions are analysis, comparison, description, evaluation, fiction writing, and problem solving. The three critical thinking skills involved in issue analysis may be developed by certain types of writing (Freedman 1994): (1) analysis (commentaries, book reviews, sequences of events, data analyses, and explanations of how something works); (2) evaluation (what ifs, taking a stand, and making decisions on an issue) and (3) problem solving (cause and effect analyses, hypotheses, letters on local issues, editorials, and speeches, proposals and interpretation of data.

A Model in Analyzing Students' Use of Critical Thinking

Environmental issue analysis is effective in developing critical thinking because students are encouraged to accept or reject statements based on evidence on matters about the environment. But a problem may exist on how to analyze responses to open-ended questions. Freedman suggests a model based on 15 critical thinking processes that are associated with understanding issues from analysis, evaluation, and problem solving.

Analysis entails perceiving several points of view, weighing evidence, making logical conclusions, identifying relationships and patterns, identifying main ideas, and identifying errors or detecting mistakes in logic.

Evaluation starts with making value judgments based on facts and figures, not only on opinions and conjectures. It also involves organizing information by comparing, classifying, ordering, representing related facts to be taken as a unified whole, and making a decision or stand on an issue. Issues and/or technical terms are clarified through further explanation, elaboration and examples. Criteria are set for judging the value or logic of ideas. Then the truth of the idea is formally confirmed or verified from the results of the

experiment or casually checked when something does not make sense.

Problem solving calls for recognition of a problem from a variety of sources, synthesizing information, clarifying issues and terms, and making generalizations or deriving general principles.

Objectives and Method

This study undertook case studies of six second year students in a public national high school in Laguna Province that offers the subject Ecology to two second year pilot sections following the EMB-DECS Environmental Science curriculum. The study specifically sought to find out the significant improvement in the students' thinking skills after analysis and discussion of local environmental issues, describe the thinking processes that the students employed before and after class discussion on the topics, and identify the teaching strategies most useful in analyzing environmental issues.

Initial Data Gathering

Initial data gathering consisted of identification of four local environmental issues, securing permission from the school, coordinating with the subject teacher and case students, and conducting classroom observations.

Four local environmental issues were identified based on personal interviews with key officials from DENR-CENRO (Community Environmental and Natural Resources Officer) and the municipal office of the town: (1) burning as a means of solid waste disposal, (2) illegal occupancy in the Mt. Makiling Forest Reserve (MFR), (3) Laguna de Bay pollution by livestock production, and (4) effects of the Makiling-Banahaw (Mak-ban) Geothermal Plant/Philippine Geothermal Plant (PGI). The issues jibed with the current lesson of the class to which the six case students belonged. The topic was "Intervention in the Environment" and was taught based on the teacher's outline of Ecology (Environmental Science).

The six case students were selected from among the 54-member class in the first section (A-1) by stratified random sampling to get two students each from the high, middle and low average groups.

The pretest-posttest questionnaire was prepared by the researcher and content-validated by environment experts. It consisted of reading paragraphs about local environmental issues and answering in writing one question for each issue in either English or Filipino. Parallel questions in Filipino were prepared for those who needed further elaboration. The students' verbatim responses were recorded and analyzed.

Gathering of information and probing through face-to-face encounter with the case students was a flexible exploratory tool. To test the validity of the students' responses to the open-ended questions, one-on-one interviews or verbal answering of questions were conducted after the pretest and posttest on each local issue.

Main Phase of the Study

The main phase of the study involved the administration of the following: pretest and interview for

the six case students, intervention/ class discussion for the whole class where the six case students belonged, and posttest for the case students only. More information were gathered from the journals of the researcher and the case students.

After the pretest and one-on-one interview, the researcher conducted intervention for a month with the whole class. The local environmental issues (LEIs) were analyzed in class discussions using seven teaching strategies.

The researcher discussed each of the four LEIs by employing two of the seven teaching strategies per session. These strategies were selected based on the list of teaching/ learning strategies adapted from the Environmental Education Guide (Asian Development Bank, 1999). The use of two strategies per session was suggested by the experts to inject variety in the classroom and to keep the students from boredom.

The issue on burning was discussed in the context of global warming through group concept mapping and issue analysis. The discussion used newspaper clippings about global warming and the students were asked to answer the guide questions. After the group presentation, the researcher discussed important points about global warming using a guide on issue analysis from Ramsey, et al. (1989) based on the following seven components:

PROBLEM:	A condition in which the status of someone or something is at risk
ISSUE:	A problem or its solution about which differing beliefs and values exist
PLAYERS:	The individuals or organizations with roles on the issue
POSITIONS:	The positions of the players concerning the issue
BELIEFS:	Those ideas concerning the issue, whether true or false held by The players
VALUES:	Those guides that tend to reflect the relative importance of beliefs in a given situation
SOLUTIONS:	The various strategies available to resolve the issue

The context of watershed management was considered in the discussion of the issue on illegal occupancy in MFR. Newspaper clippings about Mt. Makiling were given to each of the groups into which the 54-student class was divided. The group discussions started after the students answered the general guide questions and the researcher's lecture discussion. A film showing, "Saving Pasig River" (courtesy of DENR-EMB), was followed by small group discussions.

The issue on Laguna de Bay pollution from livestock production was discussed through film showing and small group discussion. Guide questions on the relation of Pasig River to Laguna de Bay were given to each group for discussion.

The effects of a geothermal plant were discussed through role playing. Questions about a geothermal plant were given as an assignment, after which a role was assigned to each student for presentation at the next meeting. A short lecture discussion

followed in which the researcher analyzed the issue. Although the intervention was intended for the whole class, only the six case students were asked to take the pretest. After the intervention, the same set of questions was administered to these students during their free time.

At the end of each class or day, the researcher made entries in a journal which reported and reflected on information relevant to the evaluation of case students' critical thinking. This journal also documented the researcher's own thoughts and the suggestions made to the students during interviews. Any response of the students that seemed unusual, incorrect or significant was noted and checked against other remarks or observations. Each case student was provided a journal to likewise record his/her reflections, feelings, reactions and ideas on what transpired during the interview, class discussion and/or during the course of the study.

Analysis of Student Responses

The data from the pretest-posttest, interview schedule, and the researcher's and students' journals were analyzed and interpreted. The students' responses to the open-ended questions before and after the intervention were compared to find out the effectiveness of the intervention as well as to determine the students' critical thinking skills. A student's response in the posttest is considered "with improvement" if the score increased, indicating an increase in number or depth of concepts, ideas and reasons. Meanwhile, a student's response is deemed "no improvement" or shows regression in the posttest if the score decreased, indicating a decrease in the number or depth of concepts, ideas and reasons. To evaluate the pretest and posttest, a modified version of Freedman's Rubric Model was used to rate the answers to open-ended questions.

The rubric model assesses two important components of the students' knowledge, namely, the content knowledge/knowledge of the issue and the critical thinking processes which the student used in expressing one's stand on the issue. To grade content on a five-point scale, the researcher developed her own rubric model (Table 1). The model includes the criteria to be

Table 1. Sample Rubric Model for Evaluation of Content and Critical Thinking

Level of performance	Criteria
5 points	Enumerates 3 bad effects of burning; explains correctly the reasons why burning should not be practiced (based on the 3 bad effects)
4 points	Enumerates 2 bad effects of burning; explains correctly the reasons why burning should not be practiced (based on the 2 bad effects)
3 points	Enumerates 1 bad effect of burning; explains correctly the reason why burning should not be practiced (based on the one bad effect)
2 points	Enumerates 1 bad effect of burning; partially explains the reason why burning should not be practiced (based on the one bad effect)
1 point	Enumerates 1 bad effect of burning; NO explanation of the reason why burning should not be practiced

considered, the description of answers (based on the table of assumed answers prepared by the researcher), and the corresponding points given to each type of answer. Content was analyzed based on the facts, concepts, illustrations, examples, reasons and evidences presented by the student. Only content was graded; no point was given to critical thinking processes because only the number of identified thinking processes employed by the students was recorded. Based on Freedman's model, critical thinking processes identified were tallied for each student.

Table 2 shows a sample model of analyzing student responses to identify the critical thinking processes employed before and after the intervention.

Table 2. Sample Model for Identifying the Critical Thinking Processes

Sample Question	Pretest Thinking Strategies	Basis (as observed in the student's responses)	Posttest Thinking Strategies	Basis (as observed in the student's responses)
Do you practice burning at home as one way of disposing your garbage? Why or why NOT? State your reasons.	Perceiving several points of view	Giving different opinions	1. Making value judgments 2. Organizing information 3. Clarifying issues 4. Setting standards	1. Valuing bad effects of burning 2. Based on information given shifts from burning to non-burning 3. Giving examples 4. Making principles based on discussion

For reliability, the evaluation of three environmental educators were considered. The scores they gave were taken to obtain the average score of each student per question about each local environmental issue.

The researcher made in-depth analyses of student responses before and after the intervention in order to identify the critical thinking processes used by the students. All questions on each LEI were first classified into analysis, evaluation and problem solving. The specific critical thinking processes involved in the reason given by the students were then identified. The overall weighted averages of each student in the pretest and posttest were also considered. To determine any improvement in critical thinking skills, the number of critical thinking processes employed by the students before and after the intervention was compared.

The students were asked to rank the seven teaching strategies used in class. They were likewise asked to suggest other LEIs which should be included in the Environmental Science curriculum aside from those discussed in the study.

Discussion of Results

Students' Knowledge of LEIs

Table 3 shows that the posttest scores are generally higher than the pretest scores. Of the 72 score analyses of 12 questions on four local environmental issues, 61 responses showed improvement. Eleven items showed no improvement (I): eight items indicated no improvement at all since the scores were the same in the pretest and posttest (NI–S), and the other three showed no improvement because the scores showed a regression to a lower score (NI-R).

Table 3. Evaluation of Students' Written Analysis based on Knowledge of the Issue

LEI		Student No.	AVERAGE PRETEST	AVERAGE POST TEST	GAIN
1	Q1	1	1.25	3.75	1
		2	2.50	3.75	1
		3	2.75	4.00	1
		4	2.00	4.50	1
		5	3.00	4.25	1
		6	1.75	4.25	1
	Q2	1	2.25	3.50	1
		2	2.50	2.50	NI-S
		3	2.75	2.75	1
		4	3.00	3.75	1
		5	2.50	3.00	1
		6	3.25	3.75	1
	Q3	1	2.25	3.00	1
		2	2.00	2.00	NI-S
		3	2.75	3.25	1
		4	2.75	4.25	1
		5	2.50	3.00	1
		6	3.50	4.75	1
	Q4	1	3.50	4.50	1
		2	3.00	3.00	NI-S
		3	2.75	3.25	1
		4	4.25	4.25	NI-S
		5	2.75	3.50	1
		6	3.00	3.50	1
2	Q1	1	2.00	3.50	1
		2	1.75	3.25	1
		3	1.75	2.75	1
		4	3.00	4.00	1
		5	2.50	3.25	1
		6	3.00	4.25	1
	Q2	1	3.75	3.50	NI-R
		2	2.00	2.75	1
		3	2.25	4.00	1
		4	3.50	4.25	1
		5	1.50	2.75	1
		6	2.75	3.50	1
	Q3	1	2.25	3.25	1
		2	2.00	3.25	1
		3	2.50	2.25	NI-R
		4	2.50	3.75	1
		5	2.50	3.50	1
		6	2.50	4.25	1
3	Q1	1	2.25	3.25	1
		2	2.25	3.50	1
		3	2.75	3.00	1
		4	2.25	3.00	1
		5	3.00	4.25	1
		6	2.00	3.75	1
	Q2	1	2.00	3.75	1
		2	1.75	3.50	1
		3	3.00	2.75	NI-R
		4	2.75	3.50	1
		5	2.75	2.75	NI-S
		6	4.50	4.75	1
	Q3	1	2.75	3.75	1
		2	2.00	3.25	1
		3	3.00	3.25	1
		4	3.00	3.50	1
		5	3.00	4.25	1
		6	3.75	5.00	1
4	Q1	1	3.50	4.00	1
		2	2.75	2.75	NI-S
		3	3.00	3.25	1
		4	3.00	3.00	NI-S
		5	2.25	2.50	1
		6	4.50	5.00	1
	Q2	1	3.75	3.75	NI-S
		2	2.25	3.00	1
		3	3.25	4.00	1
		4	3.00	3.50	1
		5	2.75	3.50	1
		6	4.50	5.00	1

*LEI – LOCAL ENVIRONMENTAL ISSUE **I – WITH IMPROVEMENT NI-R – NO IMPROVEMENT W/ REGRESSED SCORE; NI-S – SAME PRE- & POST- SCORE

TOTAL:

I (With Improvement) ---------- 61
NI-R (No Improvement due to regression from higher to lower score) ---------- 3
NI-S (No Improvement, same pre- & post- test scores) ---------- 8

The items that indicate improvement in content reflect the usefulness of the intervention. While it is true that students may have shown previous knowledge of the issue in the pretest, such knowledge increased as students gained more content-related concepts and reasons from the discussion. This is supported by Norris (1989) who said that the student's discussion of issues "is always based on their content knowledge or knowledge of the issue." Peck, as cited by Duncan (1984), also emphasized that critical thinking is "the appropriate use of reflective skepticism linked with specific areas of expertise and knowledge." Moreover, Freedman (1994) believed that responses to open-ended questions, which develop critical thinking, can be best evaluated based on content knowledge/knowledge of the issue and critical thinking processes. For instance, while analyzing the four questions about LEI 1, low scores were given to the responses. Most of the answers lacked content and were simple assumptions. However, analysis after the posttest showed improvement because most of their answers dealt with the concept being discussed. The evaluator found the answers to the posttest clearer than the answers in the pretest.

In all the questions on local environmental issues, no student got zero since no answer was considered wrong. This observation finds support in Ornstein (1990) who claims that correct answers are less important in open-ended questions than knowing how students express themselves on a particular issue.

Table 4 presents the most relevant observations on the case subjects after the intervention.

Table 4: Observations on the Case Students after Intervention

Local Environmental Issue (LEI)	Observations
LEI 1: Burning as a means of solid waste disposal	All case students showed improvement in the posttest. Before the intervention, they had many reasons for practicing burning except for one student who did not really practice it. However, after the intervention, five students changed their view on the issue because of the knowledge they gained from the discussion. From practicing burning before, they decided not to do it anymore because they realized that burning releases too much carbon dioxide that affects the earth's atmospheric temperature and lead to global warming. They also enumerated the harmful effects of global warming. During the interview prior to the intervention, many students' misconceptions were noted on why people in the provinces practice burning. According to Student Nos. 1 and 4, "burning can kill mosquitoes" since they heard this from their elders. Student No. 2 claimed that elders from Bicol told her that "burning prevents misfortunes (*malas*)." Student No. 3 reported that according to her grandmother, "the smoke coming from burning causes soil fertility and flowering of fruit-bearing trees" but he also said he was not very much convinced because of lack of evidence and he believed that this happens only as a coincidence. This was