

Local Environmental Issue (LEI)	Observations
	<p>refuted by Student No. 6 who observed that burning could cause trees to bear fruits. The intervention was deemed important because knowledge was gained as the misconceptions were changed to correct conceptions. The students learned about the alternatives to burning like composting and the 3R's (reduce, reuse, recycle). They also realized that burning has only bad effects, and never has good effects. However, the belief of Student No. 6 remained that burning has something to do with "driving away pests and allowing trees to bear fruits."</p> <p>On the effects of burning, only Student No. 2 showed no improvement in the posttest answers. The improved answers consisted of the students' enumeration of the bad effects of burning. Student No. 2's answer had the same scores in the pretest and posttest (NI-S), which meant very low score at 2.00 points, indicating lack of content. Moreover, she maintained "that burning has good effects" and "is an effective way of disposing garbage". The interview with her also revealed the same misconception.</p> <p>On the query about burning as a means of waste disposal, Student Nos. 2 and 4 had the same pretest and posttest scores (NI-S) while the other four students showed answers with improvement since they pointed out many alternatives to burning such as composting, recycling, reuse and land filling. Student No. 2's answer indicated no elaboration or further explanation on "planting more trees" although 3.00 points was considered a good score since she mentioned two alternatives. Although the answer of Student No. 4 at 4.25 points showed no improvement, it was good enough with the additional reason that burning is "not the solution to the problem of waste disposal as this results in global warming".</p>
LEI 2: Illegal occupancy in the Mt. Makiling Reserve (MFR)	<p>All six students showed improved answers in the posttest. From just one to two effects, they enumerated three to five bad effects of illegal occupancy in MFR. This was the effect of the intervention since more concepts were formed after the discussion.</p> <p>On whether MFR should be legalized, only Student No. 1 showed no improvement in the posttest (NI-R) at 3.75 points. In the pretest, she thought of many reasons why MFR should not be legalized. The reasons included destruction, pollution, overpopulation, and overuse of resources resulting in lessening of benefits derived from MFR. She added that if "the problem is unemployment, other alternative solutions are possible." In the posttest, only one reason was given, "lessening of resources due to the many occupants who depend on MFR". For this reason, the score decreased a little to 3.50 points.</p> <p>Asked about how a student can help solve the problem on illegal occupancy of MFR, five students showed improvement in the posttest; only Student No. 3 showed no improvement (NI-R). As affected by the intervention, three to five suggestions were given by the students on how to solve the problem, such as relocation, a seminar about MFR for proper orientation before the relocation, housing programs, livelihood projects, jobs, a campaign for the conservation of Mt. Makiling, hiring a forest ranger, a signature campaign, and writing to government officials about the problem. From simple suggestions given in the pretest, more realistic suggestions were given in the posttest indicating good content. At 2.50 points in the pretest, only one alternative was suggested by Student No. 3 and this was the "creation of a brigade by the government to watch the occupants". The same suggestion was given in the posttest but her thoughts were not so organized such that her score went a little lower at 2.25 points.</p>

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LEI 3: Laguna Bay Pollution by live-stock production	<p>On the question about decreasing livestock production as a significant source of pollution, four students were not in favor while two students were in favor in the pretest. In the posttest, Student No. 1 mentioned the consequences of not favoring livestock production such as no sustenance of the people's needs and loss of job, while Student No. 6 mentioned the other effects like problem on product cost and unavailability of chicken and pork. Student No. 2 suggested that the livestock wastes polluting Laguna de Bay could be converted to fertilizer. Student No. 3 believed that it should be "a two-way relationship" which is "increasing livestock production without polluting Laguna de Bay" with additional alternatives such as converting the chicken wastes to organic fertilizer, and pig wastes to bio-gas. A change in view was observed in Student No. 5. As influenced by the discussion, she emphasized the importance of employment by raising chicken and pigs. Instead of decreasing livestock production to protect Laguna de Bay, she suggested other ways to save it. However, Student No. 4 did not change her view. She emphasized that livestock production should be decreased since its wastes pollute Laguna de Bay. Moreover, she stressed that polluting Laguna de Bay by livestock wastes will lessen the benefits people get from it. This indicates that Student No. 4 was not influenced by the discussion though evidences were already shown.</p> <p>Asked about the suggestions a student can give to solve the problem on Laguna Bay pollution, four students showed improvement in the posttest. Compared with the pretest where only one or two suggestions were given, more alternatives were suggested during the posttest, as influenced by the intervention. The suggestions included burying the wastes and drying them to make fertilizer, converting the wastes to bio-gas, diversion of the flow of the livestock wastes, cooperating with the organization responsible for Laguna de Bay protection, a campaign calling for discipline among people not to dump garbage in Laguna de Bay, informing/writing to the government officials, other people and students about the problem, a visit to the place to initiate clean-up projects, information campaign about Laguna de Bay in the form of leaflets, and relocation. The response of Student No. 3 did not improve (NI-R) in the posttest. Among his suggestions was "only chicken manure can be converted into fertilizer while pig manure can be converted to a natural gas to be used as fuel". This reasoning was based on a previous knowledge in Science I. His answer decreased to 2.75 points since his thoughts were not so organized. Student No. 5 also had the same suggestion as Student No. 3 but no improvement was observed in the posttest (NI-S) because the idea was the same in the pretest at 2.75 points.</p> <p>On Q3, all the six students showed improvement in the posttest as an effect of the intervention. Although their letters, calling the attention of UPLB authorities about livestock production, were very simple in the pretest, more organized letters containing important information were observed in the posttest. The letter of Student No. 1 was not only informing the UPLB Chancellor about the problem but also giving specific solutions like burying the wastes and converting the wastes to fertilizer. Student No. 2 gave her view on the consequences of increasing or decreasing livestock production. Student No. 3 urged the authorities to immediately check on this problem as he was affected by the film the class watched. Student No. 4 focused on informing the UPLB authorities about the problem and, at the same time, asking for possible solutions/actions to the problem. Student No. 5 also asked the authorities to inform the two agencies about the effects of polluting Laguna de Bay by livestock wastes. She believed that closing it is not the solution but rather, the two institutes should be aware of the consequences of livestock wastes pollution. Likewise, Student No. 6 did not favor closing it and reiterated that action should be done immediately.</p>

Local Environmental Issue (LEI)	Observations
LEI 4: Effects of the Makiling-Banahaw (Mak-ban) Geothermal Plant/Philippine Geothermal Plant (PGI)	<p>On the question as to which is "more liable – the PGI or the government for the adverse effects of the geothermal plant," Student Nos. 2 and 4 showed no improvement (NI-S) since their responses in the pretest and posttest were the same. The other four students showed improvement. Only Student No. 2 was quite confused with her choice since at first, she blamed the local government but later shifted to PGI. She did not elaborate about her choice either. The same answer was observed in the posttest at 2.75 points. Likewise, at 3.00 points, student No. 4 believed that PGI is more liable because it is directly involved in the operation. She also mentioned the idea of the advantages/ consequences and disadvantages of the geothermal plant once it starts its operation. The improved answers were observed in Student Nos. 1 and 6 who both believed that both PGI and the local government are liable for the adverse effects caused by the geothermal power plant. As influenced by the intervention, they mentioned important reasons. In the pretest, Student No. 5 believed that PGI is more liable but, in the posttest, she changed it to the local government with better reasons. Likewise, Student No. 3 still believed that PGI is more liable.</p> <p>On Q2, Student No. 1 was in favor of the continuous operation of the plant with remedial measures such as "communicating with the local officials about the problem" so that proper action can be done. She also emphasized that "closing the power plant is not the solution". Although this was also her answer in the posttest with no additional suggestions indicating no improvement (NI-S), her score at 3.75 points was not bad at all. Likewise, Student Nos. 2, 3, 5 and 6 are in favor of the continuous operation of the plant. Though the effects were identified as power shortage since many residents depended on this for electricity and health problems, they also made a variety of suggestions such as limiting hydrogen sulfide emission, partial dependence on the plant since there are other sources of renewable materials such as charcoal, relocation of the nearby residents, proper legal action against PGI due to its harmful effects, survey on the residents' view about the plant, writing a letter to the local government expressing residents' complaint, use of generator, reinjection, and filtration. Only Student No. 4 was not in favor, but there was improvement in terms of the various advantages that can be obtained from the geothermal plant as she learned in the discussion.</p>

Critical Thinking Processes Employed

The results of the study show that the case students employed many critical thinking processes which vary from one student to another both in the pretest and posttest. The use of many thinking processes can be attributed to the open-ended questioning used in the test. As Crow (1989) pointed out, appropriate tests like open-ended queries can contribute to the development of critical thinking skills of students. Ornstein (1990) added that good open-ended questioning can arouse the student's curiosity, stimulate their

imagination and motivate them to search out new knowledge. It can challenge the students, make them think, and help clarify concepts and problems related to the lesson.

As a whole, the results indicate that all six students showed improvement in their critical thinking processes in the posttest. For instance, in the pretest, Student No. 1 was found "perceiving several points of view" in Q1 of LEI 1. This thinking skill is similar to decision making and allows one to choose the best response from many alternatives. In the posttest, an improvement was

observed in Student No. 1 since he could further "make value judgments based on facts, organize information and make firm judgments and set standards for judging the value or logic of ideas". This good number of critical thinking processes indicates that the thinking ability of Student No. 1 has become a complex activity which, according to Crow (1989), uses analysis, interpretation, logical argument action, organization, reflection, synthesis, decision making and cognitive reasoning. Thus, the posttest result indicates that Student No. 1 did not stop "perceiving points of view" but underwent a complex activity of problem solving and analysis which is attributed to the intervention made.

A very significant finding is that some students already employed some basic thinking processes like qualification and classification even in the pretest, and these processes were enriched after the intervention. According to Presseisen (1987), qualification is "finding unique characteristics by defining facts, while classification is determining common qualities, grouping and sorting, and comparing similarities and differences." For example, Student No. 2 just "qualified" in answering some questions in the pretest, but this basic thinking process changed to "making logical conclusions and making value judgments based on facts" in the posttest. This is also true to Student No. 3 who, from "qualifying" in the pretest, further thought critically by "making logical conclusions" in the posttest, and Student No. 4 who changed from "qualifying" in the pretest to "making value judgments based on facts, organizing information and making firm judgments, and setting standards for judging the value or logic of ideas" in the post-

test. The other basic thinking process - "classifying" - was employed by Student No. 5 in the pretest, but this improved in the posttest to "making value judgments based on facts, organizing information and making firm judgments, and setting standards for judging the value or logic of ideas." As comparison is made, thinking becomes higher order so that, as Ennis (1985) affirms, the meaning of a statement is grasped and value judgments are made. It is believed that both basic thinking processes were enriched by higher-order thinking processes as more knowledge in terms of concepts, ideas and reasons were learned through the intervention. Although qualification and classification are just of the basic thinking processes, this does not mean that they are of a lower order or that they are used only by young children. According to Hernandez (1991), they are used in critical thinking and other higher order thinking processes. She adds that each of these processes utilizes the essential or basic skills which include qualifying and classifying.

Among the six case students, only Student No. 6 used a variety of higher order thinking processes in the pretest and posttest, which means that all of the student's answers contained "good content." According to Norris (1989), correct concepts must be formed first so that students can effectively answer open-ended type of questions. He adds that critical thinking should be evaluated in terms of the subject matter's content because thinking critically in a subject is an essential part of mastering it. Freedman (1994) follows this up by saying that students will be able to answer open-ended questions critically depending on their knowledge of content; hence, the good number of

critical thinking processes in the pretest and posttest of Student No. 6.

The specific critical thinking processes employed by the students in the pretest and posttest are shown in Table 5. The table shows that Student No. 1 employed 10 critical thinking processes both in the pretest and posttest. Student No. 2 employed only four critical thinking processes in the pretest; this improved to 10 in the posttest. Student No. 3 used eight critical thinking processes in the pretest and nine in the posttest. In the pretest, Student No. 4 used eight thinking processes while in the posttest, she used 11. Meanwhile, Student No. 5 employed seven critical thinking processes in the pretest and 10 in the posttest. Student No. 6 employed 12 critical thinking processes both in the pretest and posttest.

It can be noted that Student Nos. 1 and 6 used the most number of critical thinking processes both in the pretest and posttest; they only lacked a few critical thinking processes in the posttest. Out of Freedman's 15 critical thinking processes, only five were not used by Student No. 1: "weighing evidence, identifying relationships and

patterns, identifying main ideas, identifying errors, verifying means confirming or proving the truth of an idea." Three critical thinking processes were not used by Student No. 6: "weighing evidence, clarifying issues and terms, and verifying means confirming or proving the truth of an idea." The non-use of the thinking processes has something to do with a little lack of content. This indicates that there is a direct relationship between knowledge of the issue/content knowledge and critical thinking. All the six case students did not employ many critical thinking processes before the intervention because of their limited knowledge of environmental issues; they used more critical thinking processes after the intervention because of more knowledge gained from the discussion.

As stated earlier, the open-ended questioning about the LEIs stimulated the students to think critically, and this thinking is dependent on content knowledge. It follows that with less knowledge of the issue before the intervention, fewer critical thinking processes were observed; as knowledge increased with the intervention, more and more critical thinking processes were observed.

Table 5. Critical Thinking Processes of the Six Cases

THINKING PROCESS	CASE 1		CASE 2		CASE 3		CASE 4		CASE 5		CASE 6	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
1. Perceiving several points of view	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Weighing evidence	✓			✓				✓			✓	
3. Making logical conclusions	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓
4. Identifying relationships & patterns				✓				✓			✓	✓

THINKING PROCESS	CASE 1		CASE 2		CASE 3		CASE 4		CASE 5		CASE 6	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
5. Identifying main ideas						✓			✓	✓		✓
6. ID errors/ detecting mistakes in logic	✓						✓		✓	✓	✓	✓
7. Making value judgments based on facts and figures, not on opinions and conjectures	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8. Organizing information and making firm judgments	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓
9. Clarifying issues and terms	✓	✓			✓							
10. Setting standards for judging the value or logic of ideas		✓		✓		✓		✓		✓		✓
11. Verifying means confirming or proving the truth of an idea			✓								✓	
12. Recognizing a problem using a variety of sources	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
13. Synthesizing information	✓	✓			✓	✓	✓	✓	✓		✓	✓
14. Clarifying Issues & Terms		✓		✓				✓		✓	✓	✓
15. Making generalizations	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
TOTAL	10	10	4	10	8	9	9	11	7	10	12	12

Teaching Strategies

Table 6 shows the case students' ranking of the seven teaching strategies employed by the researcher in the intervention. By averaging, the top three strategies for analyzing LEIs are role playing, combination of film showing and small group discussion, and film showing.

Table 6. Students' Ranking of the Seven Teaching Strategies Employed in the Study

TEACHING STRATEGY	CASE						AVE	RANK
	1	2	3	4	5	6		
Role Playing	5	3	1	1	1	1	2.0	1
Combination of Film Showing & Small Group Discussion	3	2	2	4	3	2	2.7	2
Film Showing	4	1	3	5	4	4	3.5	3
Lecture Discussion	1	6	7	3	2	7	4.3	4
Concept Mapping	6	5	6	2	6	3	4.7	5
Issue Analysis	2	4	5	7	7	5	5.0	6
Small Group Discussion	7	7	4	6	5	6	5.8	7

Role playing is mostly preferred by the students. Student Nos. 3 and 4 say that "role playing gives students a chance to express their own ideas and thoughts." For Student No. 5, role playing provides a face-to-face discussion of real issues. Similarly, Student No. 6 believes that role playing shows "the reality with feelings" by relating to real life situations. These reasons are supported by Cheriff (1995) who states that role playing provides "an engaging opportunity to discuss conflicting views on scientific issues and also demonstrates how social, political and economic issues change the direction and nature of science while exploring the moral, ethical and social dimensions of our society."

On the other hand, the teaching strategy that appears least preferred by the students varies from one student to another. For example, Student Nos. 2 and 3 find small group discussion the least useful in analyzing

local environmental issues because it is "leader-centered"; that is, since the leader of the group facilitates the discussion, there is a tendency for him to dominate it. Lecture discussion seems to be the last according to Student Nos. 3 and 1 who claim that this strategy is "teacher-centered" since it is the teacher who does the talking. Lastly, Student Nos. 4 and 5 rank issue analysis the last because "it is similar to small group discussion" where the discussion is dominated by the leader.

Conclusion and Recommendations

Although the study involved a small sample size, the findings clearly show that students do employ critical thinking processes when they analyze issues. It is hoped that the results of this study can provide a database upon which future studies on the development of critical thinking in an

Environmental Science class can be conducted. Likewise, the study's documentation of a pattern of critical thinking skills of students may help teachers, curriculum planners and school administrators in revising and innovating the Environmental Education curriculum.

This study is an example of how to assess the extent to which students think and feel critically about the environment. Educators have to be aware of the cognitive and affective capabilities of students so that a good Environmental Science curriculum can be developed and implemented. Science teachers must develop a curriculum on environment that will challenge the young people's higher order thinking skills and their desire to care for the environment.

Teachers themselves must be creative in exposing the students to more open-ended questioning during classroom discussions. This is important to develop to evaluate the student's thinking skills.

Another challenge is the use of role playing in classroom discussions which this study found to be a very effective strategy in analyzing environmental issues. Teachers must find means to include this strategy in many of their lesson plans, or perhaps as a culminating activity for each quarter.

Environmental science teachers should address the correction of misconceptions on LEIs.

School administrators should initiate a program to train teachers on how to teach and use the inquiry approach in teaching to facilitate the development of critical thinking in their students.

Similar studies should be conducted involving a larger and a more representative group of students to attain generalizability of findings. If dealing with a larger population, the instrument can be modified to a multiple choice type of test with high level questions. The effects on the student's analysis of LEIs of factors like adult verbal instruction, mediated instruction, socioeconomic status, societal influences, type of community, type of school, general ability, gender, and parents' occupation can also be considered as intervening variables for future studies.

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