The Diluted Curriculum: The Role of Government in Developing Ecological Literacy as the First Imperative in Ontario Secondary Schools

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Abstract

In 2000, the Ontario Ministry of Education removed Environmental Science *from the secondary school curriculum as single-focus, stand-alone courses. Instead, the Ministry chose to integrate or "infuse" ecological concepts in other science and geography courses. In this study, surveys were sent out to science and geography teachers across the province. Teachers were asked whether or not they taught various topics, how much time they spent teaching these topics, and how much time they spent per course teaching outdoors. The data collected from the surveys demonstrate that grade 9/10 and grade 11/12 science and geography teachers are, in fact, spending very little time teaching ecological concepts. There is a limited and ineffective emphasis on learning about environmental science topics or promoting ecological literacy in the current curriculum guidelines. The results of the study indicate the failure of the "infusion model" for ecological education. The study suggests that in light of the serious challenges the ecosphere faces in the future, ecological literacy must become the first imperative in the school curriculum.*

Résumé

En 2000, le ministère de l'Éducation de l'Ontario a retiré du programme d'enseignement secondaire tous les cours entièrement et distinctement consacrés à la science de l'environnement, choisissant plutôt d'intégrer ou d'« infuser » les concepts de l'écologie dans les autres cours consacrés aux sciences ou à la géographie. La présente étude a distribué des sondages à des professeurs de sciences et de géographie dans l'ensemble de la province, les questionnant sur les thèmes abordés en salle de classe, le nombre d'heures consacrées à l'enseignement de ces thèmes et la portion de temps passée par cours à l'enseignement en plein air. Les données rassemblées par les sondages ont montré que les professeurs de sciences et de géographie des 9e et 10e années ainsi que des 11e et 12e années consacrent en réalité très peu de temps à l'enseignement des concepts de l'écologie. Les lignes directrices du programme d'enseignement en vigueur ne mettent qu'un accent limité et inefficace sur l'apprentissage des thèmes propres à la science de l'environnement ou la promotion du savoir écologique. Les résultats de l'étude soulignent l'échec du « modèle d'infusion » des notions du savoir écologique. À la lumière des défis de taille que l'avenir réserve à l'écosphère, la présente étude recommande que le savoir écologique devienne le premier impératif du programme d'enseignement.

The events of Walkerton, Ontario have accelerated the public's perception of environmental issues, in particular with regard to the quality of drinking water in Canada. During the month of May 2000, people in that community of Ontario died because of harmful microorganisms in their drinking water. Until then, the topic of the environment seemed to be mainly pushed forward by small groups of environmentalists. Walkerton, however, shook the general public out of its lethargy and made ecological issues a societal problem.

The media was quick to take advantage of the sensational headlines of the day. However, one issue vital to the future welfare of the ecosphere (and thus to the human species) that has been overlooked is the value of education. Not only did town officials in the Walkerton incident testify that they were not aware that *E. coli* was dangerous in drinking water but also people in the Ministry of Environment who would have been designated as "experts" stated the same (Canadian Press, December 7, 2000; December 11, 2000). Not being aware of the facts about ecological problems indicates a lack of knowledge (a lack of education) and the failure of our institutions to promote an awareness of that knowledge. "What education can do that other less culturally oriented strategies cannot is build the foundations for an ecologically sustainable culture at the level of perceptions and practices that transcend generational boundaries" (Saul, 2000, p. 5). What this suggests is that the future health of the ecosphere is not just dependent upon the "experts" and technological solutions, but rather it will depend on the participation and knowledge level of a critical mass of people, that is, on the ecological literacy acquired through public education. "Resource depletion, environmental degradation, and related problems are not simply the results of technology and economy. The underlying cause is the collective behavior of individuals in a society, behavior that is predominantly cultural" (Sponsel, 1987, p. 31).

Background to Study

This current study followed the Ontario Ministry of Education's policy to eliminate environmental science from the secondary school curriculum. From 1988 until 2000, the Ministry had offered a set of courses called *Environmental Science* (Ontario Ministry of Education, 1988). One of the major limitations of this curriculum was that these courses were designated as "electives," competing with all the other elective offerings in the secondary curriculum. As a result, just over a quarter of secondary schools in Ontario offered environmental science courses (Cundiff, 1989).

In 2000, the Ministry released a new secondary curriculum and rather than reviewing and updating the previous curriculum, they chose to eliminate *Environmental Science*, the only single-focus, stand-alone courses that focused on the environment. There were many reasons given by the Minister of Education and the Ministry of Education for dropping *Environmental Science*.

In particular, it was said "[w]e are committed to having all students learn about environmental science by integrating it into the compulsory core science curriculum" (J. Ecker, Minister of Education, personal communication, May 8, 2000) and that "there are elements of environmental studies included throughout the [science] curriculum" (Ministry of Education, personal communication, May 27,1999). In both of these statements, it was also suggested that some environmental studies would be done in geography courses as well. The implication of these explanations for eliminating environmental science from the secondary curriculum was that more environmental science would be taught because it would be "integrated" in a number of different courses. This implied that the new system would be superior to the old system where environmental science was offered as single-focus elective courses in grades 10 and 12.

Outline of Study

In December 2000, surveys were mailed out to a representative sample of teachers of science and geography throughout the province (Behm, 2003). A similar mailing was conducted again in January 2001. In total, all regions and all boards of education in the province were surveyed. Two surveys were designed, one for grade 9/10 teachers and one for grade 11/12 teachers. In the grade 9/10 survey, topics from the Ministry of Education's previous *Environmental Science Grade 10 Part 8* curriculum guidelines (Ontario Ministry of Education, 1988) were used to develop the questionnaire. This questionnaire surveyed 10 groupings (units) of topics and 5-9 topics per grouping. Science and geography teachers were asked whether or not they taught or planned to teach each topic and, if they did teach the groupings of topics (as designated by the unit), how much time they spent on each one. In addition, data regarding how much time teachers spent teaching these topics outdoors was collected. A similar process was used to develop the grade 11/12 survey, using topics from the previous *Environmental Science Grade 12 Part 8* curriculum guidelines (Ontario Ministry of Education, 1988). This latter survey also included 10 groupings with 5-9 topics per grouping.

There were 250 surveys sent out at each level. By the end of March 2001, 119 responses for the grade 9/10 survey and 107 for the 11/12 survey were received.

Results: Grade 9/10

The results for both surveys are very similar in that they demonstrate that very little ecological education is being taught in Ontario secondary schools; even though the results are similar, they represent two different surveys and we felt it was important to report on the extensiveness of this trend in each case.

Microbiology

The most important aspect of Walkerton was that both experts and average citizens reported that they did not know that *E. coli* could be a serious health problem in drinking water. In this study, teachers were asked whether or not they taught nine topics that related to drinking water, under the unit heading "microbiology." As shown in Table 1, the results are quite startling. Eighty-three per cent didn't teach about "types of micro-organisms," 87.5% didn't teach about "harmful micro-organisms" (such as *E. coli*, giardia, and cryptosporidium), 90% didn't teach "control of bacteria," 92% didn't teach about "growing conditions for bacteria," and 61% didn't teach about "the role of micro-organisms." All of these topics would be considered vital in preventing incidents similar to the one which occurred in Walkerton.

Teachers were also asked to indicate how much time they spent teaching the topics found in Table 1. Fifty-nine percent didn't teach any topics in this grouping at all and 98% covered some or all of these topics in less than 5 hours. Only 1% spent 16 hours or more teaching these concepts. What is critical to note is that under the previous Ministry of Education policy (as found in the *Environmental Science* guidelines), the minimum amount of time that teachers were advised to spend on these topics was 16 hours (1988, p. 27).

Microbiology	% of Teachers who did not Teach the Topic	% of Teachers who Taught the Topic
Growing conditions for bacteria	92%	8%
Types of micro-organisms	83%	17%
Culture techniques	98%	2%
Distribution of bacteria	92.5%	7.5%
Role of micro-organisms	61%	39%
Structure of micro-organisms	91.5%	8.5%
Harmful micro-organisms	87.5%	12.5%
Control of bacteria	90%	10%
Industrial and commercial uses of micro-organisms	90%	10%
Total amount of time spent teaching these topics	59% did not teach any topics; 79% taught 1 hour or less 98% taught less than 5 hours; 1% taught 16 hours or more	
Amount of time required under previous guidelines	16 hours minimum	

Table 1. Microbiology Grade 9/10.

Summary of Other Topics

The results for eight other groupings of topics are summarized in Table 2. The first column represents the average number of teachers who reported that they did not teach the topic featured (the average taken over all the topics in each grouping). The second column represents the amount of time that teachers

spent teaching the grouping of topics. In the two groupings of Natural Environment and Population Ecology, the vast majority of teachers said that they taught most of the topics. However, when asked how much time they spent on teaching the topics in each grouping, 72% said they taught 10 hours or less in the Natural Environment grouping and 64% reported teaching 4 hours or less in the Population Ecology grouping. Under the previous Ministry of Education policy (as found in the *Environmental Science* guidelines), the minimum amount of time that teachers were advised to spend on these topics was 15 hours for the former and 16 hours for the latter. In all the other groupings, the previous minimum time required was 16 hours, except for Energy which was 15 hours.

Topic	Average % of Teachers who did not Teach Each Topic Within Grouping	Amount of Time for all Topics
Soil Science	47% over 8 topics	19% did not teach any topics 80% taught 5 hours or less
Terrestrial Ecosystem	39% over 5 topics	21% did not teach any topics 78% taught 5 hours or less
Energy	48% over 5 topics	28% did not teach any topics 85% taughtt 5 hours or less
Essentials of Plant Science	58% over 9 topics	29% did not teach any topics 81% taught 4 hours or less
Natural Environment	21% over 8 topics	15% did not teach any topics 72% taught 10 hours or less
Population Ecology	27% over 6 topics	15% did not teach any topics 64% taught 4 hours or less
Forestry	70% over 8 topics	25% did not teach any topics 85% taught 3 hours or less
Plant and Animal Reproduction	49% over 5 topics	39% did not teach any topics 65% taught 5 hours or less

Table 2. Summary of Additional Grade 9/10 Results.

Ontario Ministry of Education Science Curriculum Guidelines Grades 9/10

One might conclude from the data presented in the previous section that the problem of very little ecological education being taught in schools is simply because teachers are not teaching it. In fact, further analysis would suggest this is not the reason at all. Teachers are not teaching ecological education for two main reasons:

- there isn't very much of it in the new science guidelines; and
- there is no time available within the extensive science guidelines for teachers to voluntarily add ecological topics to the curriculum.

Teachers are teaching what is in the guidelines. They are not teaching ecological education because there is very little of it in the guidelines.

In 1998, the Ontario Society for Environmental Education released a study (OSSE, 1998) it conducted of the new provincial *Science* guidelines (Ontario Ministry of Education, 1999) for grades 9 and 10. This was an analysis of the number of specific environmental expectations (previously known as objectives) included in the new science guidelines. In the grade 9 academic science course, there are a total of 66 specific expectations. The study found a total of 9 expectations out of 66 (i.e., 13.6%) that could be described as being about the environment. The total number of specific expectations dealing with the environment for the grade 9 applied course is 14 of 58 (24%) (p. 1). The Ontario Society for Environmental Education analysis of the grade 10 academic science course concluded that there are 23 out of a total 63 expectations (36.5%) for the course that deal with the environment. The total expectations that feature the environment for the grade 10 applied science course is 19 out of 56 (33.9%). What is worse about these numbers is that the Ontario Society for Environmental Education report (1998) stated that "[t]he decision to include an expectation in one of the three types was made *fairly liberally*" (p. 1, author's emphasis). The Ontario Society for Environmental Education report went on to state that "the Ontario Society for Environmental Education believes it evident . . . that most courses do not contain sufficient or appropriate expectations" (p. 2) to meet the Ministry of Education's own goals for environmental education.

The results of the current survey for grades 9/10 should not be surprising. In the previous provincial curriculum, there was a grade 10 environmental science course and a grade 10 science course (Ontario Ministry of Education, 1988). In the new science curriculum, these two former courses, each with a single focus, were combined into one course with half the amount of previously mandated instructional hours. Under these circumstances, there had to be less of something and, unfortunately, through the elimination of two single-focused courses at the academic level and two also at the general level, environmental science took the "hit."

Results Grade 11/12

Environmental Quality: Air

Teachers were asked whether or not they taught any of the five topics in the category of "environmental quality: air" (see Table 3). Sixty-two percent stated that they did not teach "air monitoring and pollution control" while 38% did. Sixty-eight percent indicated they did not teach "particulate matter" while 32% did. Forty-nine percent stated they did not teach atmospheric contaminants" whereas 51% did. In the other topics including "nutrient cycles" and "characteristics of atmosphere," the percent of teachers who didn't teach these topics ranged from 55-62%.

Environmental Quality: Air	% of Teachers who did not Teach the Topic	% of Teachers who Taught the Topic
Characteristics of atmosphere	55%	45%
Atmospheric contaminants	49%	51%
Nutrient cycles	62%	38%
Particulate matter	68%	32%
Air monitoring and pollution control	62%	38%
Total amount of time spent teaching these topics	35.5% did not teach any topics; 53% taught 1 hour or less; 80% taught 5 hours or less; 8% taught 10 hours or more	
Amount of time required under previous guidelines	12 hours minimum	

Table 3. Environmental Quality: Air
Grade 11/12.

Teachers were asked how much time they spent teaching these five topics. Thirty-five and a half percent did not teach any of these topics. Eighty percent taught some or all of these 5 topics in 5 hours or less. Under the previous Ministry of Education (1988) policy (as found in the *Environmental Science* guidelines), the minimum amount of time that teachers were required to spend on these topics was 12 hours.

Summary of Additional Grade 11/12 Results

The results for 9 other groupings of topics are summarized in Table 4. The first column represents the average number of teachers who reported that they did not teach the topic featured (the average taken over all the topics in each grouping). The second column represents the amount of time that teachers spent teaching the grouping of topics. There were 55 topics overall in these other 9 groupings and the average number of teachers reporting that they did not teach each of the topics in each category was over 50%. When asked how much time was spent teaching each grouping of topics, 70-80% reported that they spent 5 hours or less in each grouping of topics. Under the previous Ministry of Education (1988) policy (as found in the *Environmental Science* guidelines), the minimum amount of time that teachers were advised to spend on these topics was 16 hours per grouping.

Topic	Average % of Teachers who did not Teach Each Topic Within Grouping	Amount of Time for all Topics
Environmental Quality Water	54 % over 6 topics	30 % did not teach any topics 84 % taught 5 hours of less
Environmental Health Hazards	60 % over 5 topics	32 % did not teach any topics 81 % taught 3 hours or less
Fish and Wildlife	68 % over 5 topics	56 % did not teach any topics 82 % taught 4 hours or less
Plants, People, and Environmental Modification	76 % over 8 topics	40 % did not teach any topics 74 % taught 5 hours or less
Energy Resources	54 % over 5 topics	44 % did not teach any topics 74 % taught 5 hours or less
Soils	69 % over 4 topics	57 % did not teach any topics 83 % taught 3 hours or less
Pests and Pest Control	70 % over 6 topics	52 % did not teach any topics 80 % taught 3 hours or less
Aquatic Ecosystems	61 % over 7 topics	43 % did not teach any topics 73 % taught 5 hours or less
Applied Genetics	61 % over 4 topics	58 % did not teach any topics 80 % taught 5 hours or less

Table 4. Summary of Additional Grade 11/12 Results.

Ontario Ministry of Education Science Curriculum Guidelines Grades 11/12

During the 2000-2001 school year, the new grade 11/12 curriculum (Ontario Ministry of Education, 2000) was not yet compulsory. Some teachers may have been using the new curriculum. Others may have still been using the previous curriculum. Whichever was the case, it is certain that the vast majority of grade 11/12 students are not being adequately taught ecological education. However, there is no reason to believe that the new grade 11/12 curriculum will produce better results than the new grade 9/10 curriculum has (Bower & McEwan, 1999). Previous analysis by the Ontario Society for Environmental Education (1998) has demonstrated that there is little emphasis on environmental outcomes in the new grade 11/12 science guidelines. The results of our study suggest that teachers are struggling to cover all the non-environmental expectations which form the vast majority of expectations in the grade 11/12 science courses.

Teaching Ecological Literacy Outdoors

Although the survey was not primarily about how teachers teach ecological education, one fundamental question that has a large bearing upon pedagogy was included. Teachers were asked how much time per course they taught outside the school. At the grade 9/10 level, 21 % of teachers said that they never teach any of their classes outdoors. Sixty-four and a half percent

taught in the outdoors less than 5 hours. In total, 85.5% either did not teach outdoors at all or taught for less than 5 hours. What is interesting to note is that under the previous *Environmental Science* curriculum guidelines (Ontario Ministry of Education, 1988), teachers, at the grade 9/10 level, were required to take students on mandated field trips. At the 11/12 level, 36% of teachers did not provide any instruction outdoors and 41% taught less than 5 hours outdoors. In total, 77% of teachers either did not teach outdoors at all or spent less than 5 hours teaching outdoors.

Many studies have indicated that experiences in the outdoors (and in particular experiences in natural areas) is the number one influence on why people develop environmental sensitivity (James, 1993; Palmer, 1993; Tanner, 1980) and commitment to environmental protection (Chawla, 1999). In particular, outdoor experiences at an early age have positive long-term effects. "[C]hildhood experience in the outdoors is the single most important factor in developing personal concern for the environment" (Palmer, 1993, p. 29). A study by Lisowski and Disinger (1991) found that "field-based programs in the sciences are effective in assisting students' understanding and retention of selected ecological concepts" (p. 23) and that students "exhibited statistically significant post-test gains and showed evidence of retaining the targeted concepts" (p. 19).

As indicated earlier, there is very little environmental science in the new Ontario secondary *Science* guidelines and without a strong focus on ecological concepts, teachers most likely feel they must cover the "main" science concepts (biology, chemistry, physics) and can not afford to devote precious time to field trips for the small percentage of environmental concepts that exist in the guidelines.

Influences on the Ontario Science Curriculum

While there are no doubt many reasons for the government's actions in eliminating *Environmental Science* that the public is not privy to, one reason was made public. The Minister of Education acknowledged that the new secondary science curriculum was consistent with the Pan-Canadian Common Framework of Science Learning Outcomes K to 12 (Council of Ministers of Education, 1997), which did not include environmental science as a discreet subject (J. Ecker, Minister of Education, personal communication, May 8, 2000).

Puk (1999) has described previously the influence that the Third International Mathematics and Science Study (TIMSS) conducted in 1994 (Martin & Kelly, 1996) had on the development of the Pan-Canadian Protocol. The Third International Mathematics and Science Study was an international standardized test, composed mainly of multiple choice questions, used by 45 countries to ascertain the scientific and mathematical knowledge of students throughout the world. Unfortunately, the Third International

Mathematics and Science Study did not include environmental science as a discreet subject heading. Puk (1999) expressed concern that the "jurisdictional educultural integrity" (p. 225) of Ontario's curriculum has been eroded by the slavish practice of following what other jurisdictions in the world do (in particular the ones that scored higher in the Third International Mathematics and Science Study than Ontario), rather than developing its own Ontario science curriculum policy. As a result, *Environmental Science* (Ontario Ministry of Education, 1988) was dropped as a discreet subject area. Ontario which was once a leader in this area by having the foresight to create *Environmental Science* has fallen behind other North American jurisdictions.

The Inadequacies of the Infusion Method for Ecological Education

Much has been written about the benefits of integrating subject matter (much of this in the form of testimonials), and in particular integrating environmental education into other subject areas (Lieberman & Hoody, 1998; National Environmental Education Advisory Council, 1996). Implicit in the term "integration" is the belief that there will be more environmental concepts in the integrated curriculum because they will be found in a number of subject areas. This further translates into the belief that "more must be better." However, what the results of this survey clearly indicate is that there are serious shortcomings in our understanding of the substantive limitations of integration or "infusion." "In a majority of cases, environmental education programs have been implemented through the process of infusion. This strategy involves placing relevant environmental topics in existing subject offerings with a high percentage of the topics being assimilated into science" (Rejeski, 1982, p. 27). An everyday example of infusion would be when we place tea into water and we say that the tea infuses or "steeps" into the water and the more it steeps the stronger the tea tastes. However, infusion can also lead to dilution (i.e., the weakening of the forcefulness of the substance) in two ways: by adding too little tea and/or by adding too much water.

What the results of this survey clearly demonstrate is that infusion, rather than strengthening environmental science, has had the opposite effect and has led to *the dilution of ecological literacy in the Ontario curriculum*. In one previous study of a secondary school which attempted to infuse environmental education into the school curriculum, Samuel (1993) found that the attempt caused confusion because of the limited knowledge teachers possessed of the subject-matter. Lane, Wilke, Champeau, and Sivek (1994) found similar problems to those in the Samuel study: lack of specific environmental knowledge on the part of teachers and an inability to see connections between their discipline and environmental education. Problems with infusion should come as no surprise as Singletary (1992) previously found that "secondary teachers have specialized training in one discipline, making it difficult

for an individual teacher to incorporate the variety of perspectives necessary for comprehensive coverage of environmental issues" (p. 36). Hines, Hungerford, and Tomera (1986/87) found that sporadic exposure to environmental issues had little effect in creating environmentally-responsible behaviors. As Knapp (2000) suggests, infusion has been "a delusion of substantial proportion" (p. 33). There are too few ecological concepts spread out in too many other subject areas such as in the other sciences and geography. "Add to this the supplemental approach that teachers were going to "infuse" every part of the curriculum with environmental education, and you have a recipe for failure" (Van Matre, 1990, p. 13).

Another problem with infusion is the lack of a sequential order for developing ecological literacy within individual courses and from grade to grade. Ecology, by being infused and thinly spread out into other subjects, has lost its distinct identity. The espoused rhetoric that environmental education is important is still there, but the de facto implementation translates into unfocused curriculum and the unfulfilled establishment of a knowledge base. Therefore, to fill the "token" weekly quota, well-meaning but unsupported teachers often rely on the supplemental "activity-guide mentality" in an attempt to address the ecological concepts that they believe to be important.

> For the most part, environmental education has taken the easy way out. Agencies and institutions associated with environmental education have produced an amazing number of activity packets or curriculum guides. Programs such as Project Wild and Project Learning Tree, although well meaning... have created an "activity-guide mentality." Budgets, time constraints, and the desire to make one's own mark on the field have brought about those myriad offerings that do not represent a sequential learning order based on a sound educational philosophy. They have offered trainers and trainees an easy way out by picking and choosing an activity here and there that will be considered the environmental lesson of the day- or week (Knapp, 2000, p. 34).

Teachers may want to teach more ecological concepts but they feel under pressure to "cover the subject" (Farman & Hollins, 1981, p. 510), i.e., all the other non-environmental objectives which make up the majority of science and geography courses.

Integration may be a positive concept but the problem arises in its implementation. *Integration may be beneficial if, and only if, ecological education is at the same time a discreet, single focus set of courses like all the other school courses*. Ecological education courses as single focus offerings would then provide the ongoing, in-depth support for the integration of ecological concepts into other subject areas. However, if it comes down to a choice between integration or single focus, the results of this survey favour single focus.

> Rather than continuing with an interdisciplinary infusion model, I urge educators to integrate environmental education in a block approach, in which separate and distinct environmental education courses are offered. That approach can offer

> the depth that is missing in the infusion process . . . . An interdisciplinary curriculum can be taught in the confines of a single-subject framework. (Knapp, 2000, p. 36).

Recommendations

The results of this survey clearly demonstrate that the infusion model for ecological education is not working in the secondary schools of Ontario. Students are not being taught the critical concepts of ecological education. Thus, the future leaders of Ontario are not being properly prepared to take an active role in protecting the ecosphere. Infusion has led to a dilution of ecological literacy in public education. Society has lost valuable time in working towards ecological literacy for everyone. Therefore the following recommendations are suggested to correct the problem.

A New Meta-Discipline "Ecological Education" Should be Created

Ecological education should be developed as a meta-discipline in the Ontario school curriculum (Puk, 2002), composed of an enriched subject-matter including sciences, social sciences, economics, health, philosophy, aesthetics, ethics, etc. Whenever a student is studying about the ecosphere, s/he should be looking at it from a multi-perspective viewpoint rather than a monistic discipline-based perspective, which creates misleading and harmful separations. This term would incorporate terms such as environmental education, environmental studies, and environmental science. The purpose of this meta-discipline should be to create ecological literacy in schools and throughout society. The focus should be on ecological concepts of energy, air, water, soil, flora, and fauna (including the human species), and their relationships to each other (both the big picture and the details), and to the active preservation of the ecosphere (Puk, 2002).

Compulsory, Discreet Ecological Courses Should Serve as the School Hub

Compulsory, distinct ecological literacy courses in secondary schools should be created and only then should ecological education be harmonized into other subject areas. Ecological literacy courses must serve as the hub for the school curriculum. This new curriculum should move beyond simple concepts such as recycle, reduce, and reuse. Many scientists believe that we may be approaching a time very soon (if not now) when changes occurring in the environment will become irreversible (Wilson, 2002). Thus, the curriculum for ecological sustainability will require fourth and fifth "r's," that is, refuse and rethink/reconceptualize. This new curriculum should focus on ways to rethink how we conduct our daily lives and the ways in which we interact with the environment—which presently are not ecologically sustainable. This

curriculum needs to reconceptualize our relationship with the ecosphere. Terms such as "renewable resources" will need to be redefined because at the present rate we are using our natural resources, they will not be able to be "renewed" in time to be reusable (Puk, 2002, p. 31).

A Sequenced Curricula Should be Age-Sensitive

A sequential order for teaching ecological concepts within each course and from grade to grade should be developed. This sequence needs to begin at the elementary level and continue through the secondary years. As Sobel (1995) points out, young children can suffer "ecophobia" when too much responsibility for global problems is introduced at too early an age. Young children need to rejoice in the wonders of the natural world rather than experiencing guilt for the loss of the rain forests. The new curricula must be ever vigilant of the emotional impact that stories about the suffering environment can have on developing minds. This curricula should be age- and maturity-sensitive.

Ecological Literacy Should be Acquired Through Experiential Learning

Ecological education and outdoor experiential learning need to be closely aligned. Using Simmons' (1998) categories for outdoor learning, students should spend significant amounts of time in any of four different natural environments:

- rivers, ponds, and marshes;
- deep woods;
- county park; and
- urban nature. (p. 24)

Ecology needs to be studied first hand in the natural settings where it exists, i.e., outside the classroom. In the past, it has been assumed mistakenly that environmental education and/or outdoor education are undertakings common only to rural, northern, and wilderness locations. In fact, air, water, soil, flora, fauna, and their physical locations are found everywhere. The urban environment is a rich setting for ecological explorations. Most urban areas have within their boundaries lakes/ponds, shorelines, rivers, streams, wetlands, gravel pits, ravines, parks, farms, woodlots, landfill sites, waste disposal services, water treatment plants, etc.

Teacher Education Should be Revamped

Various authors have described the challenges facing teachers in teaching ecological concepts and teaching in the outdoors (Cherif, 1992; Simmons, 1998). McKeown-Ice (2000) and Lin (2002) found that very little emphasis is placed on environmental education in the majority of preservice teacher education

programs. Thus, a systematic model for preservice and inservice training must exist in order to thoroughly prepare teachers. Teachers need a solid foundation so that they do not become dependent upon activity-guides. Some degree of ecological literacy should be compulsory for all new teachers as well as discrete programs for specialists (i.e., by maintaining/creating a teachable).

Research Funding for Acquiring Ecological Literacy is Critical

Governments at various levels need to fund research into the best practices for teaching ecological literacy. Much of what is taught in schools doesn't necessarily have any lasting effects. We need to determine what works best to create knowledgeable, active, and caring citizens. Schooling in general must be fundamentally reconceptualized (e.g., learning for internalization does not occur in atomistic, 40-70 minute disparate episodes). Extended explorations outdoors will require a more fluid use of the instructional day.

Conclusion

There are many priorities in life and in education. However, we can no longer afford to relegate ecology to elective status. Ecological literacy should be viewed as being the *first imperative* in schooling and in society. If we don't have clean water, air and soil, then jobs, family, trade, and everything else, become redundant. Without a liveable ecosphere, all other priorities of life become moot. Love and concern for the environment is love and concern for all else. The school curriculum should be revamped in order to reflect these current realities.

Notes on Contributors

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References

Behm, D. (2003). *The status of environmental science in Ontario secondary schools*. Unpublished MEd Project, Faculty of Education, Lakehead University, Thunder Bay, Canada.

Bower, J. & McEwan, S. (1999). Where is the environment in Ontario's science curriculum? *Crucible*, *31*(1), 9-10.

Canadian Press. (2000). Town foreman describes phoney water testing. *The Chronicle Journal*, December 7. Thunder Bay: *Chronicle Journa*l.

Canadian Press. (2000). Anger, sympathy wage war in troubled heart of community hit by *E coli*. *The Chronicle Journal*, December 11. Thunder Bay: *Chronicle Journal*.

Chawla, L. (1999). Life paths into effective environmental action. *Journal of Environmental Education*, *31*(1), 15-26.

Cherif, A.H. (1992). Barriers to ecology education in North American high schools. *Journal of Environmental Education*, *23*(3), 36-46.

Council of Ministers of Education. (1997). *Common framework of science learning outcomes: Pan-Canadian protocol for collaboration on school curriculum*. Ottawa, ON: Author.

Cundiff, B. (1989). Reading, writing and the environment. *Seasons*, *29*(3), 16-19.

Farman, G. & Hollins, E. (1981). Citizenship and the infusion game. *Phi Delta Kappan*, *62*(7), 510-512.

Hines, J., Hungerford, H., & Tomera, A. (1986/87). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *Journal of Environmental Education*, *18*(2), 1-8.

James, K. (1993). *A qualitative study of factors influencing racial diversity in environmental education*. Unpublished PhD dissertation, College of Education and Human Development, University of Minnesota, Minneapolis.

Knapp, D. (2000). The Thessaloniki declaration: A wake-up call for environmental education? *Journal of Environmental Education*, *31*(3), 32-39.

Lane, J., Wilke, R., Champeau, R., & Sivek, D. (1994). Environmental education in Wisconsin: A teacher survey. *Journal of Environmental Education*, *25*(4), 9-17.

Lieberman, G.A. & Hoody, L.L. (1998). *Closing the achievement gap*. Poway, CA: Science Wizards.

Lin, E. (2002). Trend of environmental education in Canadian pre-service teacher education programs from 1979 to 1996. *Canadian Journal of Environmental Education*, *7*(1), 199-215.

Lisowski, M. & Disinger, J.F. (1991). The effect of field-based instruction on student understandings of ecological concepts. *Journal of Environmental Education*, *23*(1),19-23.

Martin, M.O., & Kelly, D.L. (Eds.). (1996). *Third international mathematics and science study: Technical report, volume 1*. Chestnut Hill, MA: Boston College.

McKeown-Ice, R. (2000). Environmental education in the United States: A survey of pre-service teacher education programs. *Journal of Environmental Education*, *32*(1), 4-11.

National Environmental Education Advisory Council. (1996, December). *Report assessing environmental education in the United States and the implementation of the national environmental education act of 1990*. Washington, DC: Author.

Ontario Ministry of Education. (1988). *Environmental science part 8 grades 10 and 12, advanced level*. Toronto: Queen's Printer.

Ontario Ministry of Education. (1999). *Science*. Toronto: Queen's Printer.

Ontario Ministry of Education. (2000). *Science*. Toronto: Queen's Printer.

Ontario Society for Environmental Education. (1998). *Analysis of draft secondary curriculum for environmental outcomes*. Ontario: Author.

Palmer, J.A. (1993). Development of concern for the environment and formative experiences of educators. *Journal of Environmental Education*, *24*(3), 26-30.

Puk, T. (1999). Formula for success according to TIMSS or subliminal decay of jurisdictional educultural integrity? *The Alberta Journal of Educational Studies*, *45*(3), 225-238.

Puk, T.G. (2002). A new meta-perspective "ecological education" should be created. *Interactions*, *14*(3), 30-31.

Rejeski, D.W. (1982). Children look at nature: Environmental perception and education. *Journal of Environmental Education*, *13*(4), 27-40.

Samuel, H. (1993). Impediments to implementing environmental education. *Journal of Environmental Education*, *25*(1), 26-29.

Saul, D. (2000). Expanding environmental education: Thinking critically, thinking culturally. *Journal of Environmental Education*, *31*(2), 5-8.

Simmons, D. (1998). Using natural settings for environmental education: Perceived benefits and barriers. *Journal of Environmental Education*, *29*(3), 23-31.

Singletary, T. (1992). Case studies of selected high school environmental education classes. *Journal of Environmental Education*, *23*(4), 35-40.

Sobel, D. (1995). Beyond ecophobia: Reclaiming the heart of nature education. *Clearing*, *91*(Nov./Dec.), 16-20.

Sponsel, L.E. (1987). Cultural ecology and environmental education. *Journal of Environmental Education*, *19*(1), 31-42.

Tanner, T. (1980). Significant life experiences. *Journal of Environmental Education*, *11*(4), 20-24.

Van Matre, S. (1990). *Earth education*. Greenville, WV: The Institute for Earth Education.

Wilson, E.O. (2002). *The future of life*. New York: Alfred A. Knopf.