

# FEATURE ARTICLES

## WHAT PREVENTS BIOLOGY TEACHERS FROM TEACHING ECOLOGY EFFECTIVELY IN B.C.?

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Teaching ecology seems to face more problems than any other area of biological science. This study is undertaken to examine teachers' views of the issues that prevent them from teaching ecology effectively. It is divided into two parts. Part one provides a literature review centred on the issue of what prevent biology teachers from teaching ecology effectively, while part two presents responses of several B.C. biology teachers to that literature review. Following this, the same teachers give their own views of what prevents them from teaching ecology effectively at the secondary school level.

### Part One

#### INTRODUCTION

Numerous educators have agreed that the teaching of ecology presents a difficult task at any level, especially in the field (e.g. Booth, 1979; Harper, 1982; Wells, 1982; Hale, 1986b, Cherif, 1989). Teaching ecology has been seen to pose more special problems, both intellectual and administrative, than does any other area of biology (Dowdeswell and Potter, 1974; Dowdeswell, 1979). As a result, ecology topics are poorly represented in teaching syllabuses and examination schemes (Moss and Theobald, 1979; Booth, 1979). In the literature we find 7 reasons for the difficulties teachers face in teaching ecology which may be summed up as follows<sup>1</sup>:

- The nature of ecology.
- Confusion about how to teach ecology.
- Lack of appropriate samples of examination syllabuses and papers.
- Lack of teacher confidence in dealing with ecological issues as well as in identifying local flora and fauna.
- A shortage both of appropriate facilities and of inexpensive equipment.
- A perceived dichotomy between practical and theoretical ecology.
- Lack of emphasis on observation skills in science education.

#### THE NATURE OF ECOLOGY

The very nature of ecology presents a problem in teaching it. Booth (1979) claims that the subject is elusive as it means many things to different people. He notes, for example, that within the discipline there are many models, each containing specific terms and language which can be confusing to the ecology teachers. Although Harper (1982) disagrees with Booth's claim, he urges that ecology at the school level does

not exist as a subject despite all attempts to introduce it. He suggests that ecology should be introduced as a joint theme with physiology. Dowdeswell (1979) sees the problem regarding the nature of ecology on a more basic level than did either Booth or Harper. He suggests a more holistic, integrative approach, an idea that has been replicated in more recent work in Project Wild.

Ecology has been described by McIntosh (1988) as "more a bush with multiple stems and a diffuse rootstock than a tree with a single, well-defined trunk and roots" (p. 7). Its sources and boundaries are still a continuing problem, he explains. But regardless of this fact, literature indicates that in order to teach ecology successfully and to fulfill the purpose of ecological education, teachers must understand its true nature (at least in terms of what ecologists did/do) and communicate this knowledge to their students.

#### CONFUSION IN TEACHING ECOLOGY

Booth (1979) summarizes five issues causing teachers difficulty in teaching ecology. These include:

1. The isolation of ecology as a separate topic within a biology or science course rather than treating it as an integral part of the course (cf. Harper, 1982 and Hale, 1986).
2. A tendency to treat ecological work as "project" work lacking the more precise end-points of other experimental (or exercise based) work.
3. A tendency to look for new discoveries in ecology rather than working towards end-points which are within definite limits of which at least the teacher is aware.
4. The use of techniques (e.g. use of quadrants, transects) without defining what questions are being asked, often for the sake of the technique only.
5. Attempts to take on complicated tasks in which the number of variables involved makes progress almost impossible (p. 262)

Dowdeswell (1979) believes that teachers attempt to deal with too many diversified habitats and ask unnecessarily complex questions about ecosystems instead of using simple analogies from the surrounding community as starting points, and thus encourage an experimental approach to specifically defined questions or problems. Booth (1979) agrees. This confusion leads teachers to use methods which usually result in unsatisfactory outcomes (e.g. a lack of any real understand-

<sup>1</sup>The first five factors above were identified from the literature and other sources almost ten years ago by Booth (1979). The last two factors in the list have been noted by other writers (e.g. Wells, 1982; Norris, 1985). Most of the above stated factors have also been mentioned by mentioned by many others (i.e., Hale, 1986b, Ham & Sewing, 1987/88, Uma, 1988).

ing among students).

Knowledge and attitudes of teachers themselves have also been cited as a reason for difficulties in teaching ecology. Towler (1980-81) asserts:

Teachers who are not prepared or trained to teach EE cannot help but have a neutral if not a negative attitude towards the subject and its importance. . . (and) if they are required to teach it, they will find themselves somewhat disadvantaged in trying to do so. (p. 15)

The need for environmental teacher education at the secondary school level to alleviate such problems seems urgent (Volk, Hungerford and Tomera, 1984).

### LACK OF EXPERIENCE IN EVALUATING STUDENTS PERFORMANCE IN ECOLOGY

Booth (1979) and Moss and Theobald (1979) found that students answering ecology questions obtained lower marks than those who answered other questions in biology examinations, even when ecology was a specified part of the curriculum.<sup>2</sup> There is considerable controversy among teachers on how to introduce ecological questions to students and how to examine their knowledge and understanding of ecology. According to Booth (1979):

Some teachers feel that some form of coursework or internal assessment is essential. There is some relationship between this view and some of the traditional views of ecology teaching. Examination questions may have encouraged the teaching of "theoretical ecology" with little or no firsthand experience. Internal assessment would ensure that data was obtained firsthand. (p. 263)

Failure to include ecology on the final exam has also been connected to the difficulties teachers face in teaching ecology. It might help to solve the problem if ecological concepts and principles are always included as a part of classroom teaching and student evaluation.<sup>3</sup> If ecology is included in the final exam, teachers will not only teach it, but also develop the skills and techniques necessary for better student evaluation. Eichler (1977) convincingly argues that if ecological and environmental themes were included in secondary school examinations, both teachers and parents might give more serious attention to the subject. Booth (1979) agrees with view in stating that "unless examinations and their syllabuses demand that ecology is an integral part of biology and science courses, it is unlikely that much ecology will be taught in science" (Eichler, 1977, p. 263).

### LACK OF TEACHER CONFIDENCE IN DEALING WITH ECOLOGICAL ISSUES AND IN IDENTIFYING LOCAL ORGANISMS

Many teachers lack confidence, especially regarding the

identification of organisms in ecology teaching (e.g., Booth, 1979; Hale, 1986). It is inevitable that teachers who have never been trained to develop identification skills or use them in teaching will at a disadvantage. Teachers are aware of this lack; in the U.S.A., for example, high school science teachers rated the "identification of flora and fauna" and the "improvement of habitat for desired flora and fauna" as eighth and eleventh in importance among twenty-seven outdoor natural science activities (Keown, 1986). It may be inferred that the development of such identification skills (which includes observation, capturing, recapturing, collecting, recording, sampling, identification and characterizing the species and analyzing data) is seen by those authors as necessary for every successful biology teacher. Unfortunately, many college biology programs are no longer interested in teaching these things. Yet, environmental education programs "... will not be effective and relevant when animals, plants, and the nature of their habitats are mostly unknown" (Jun-Y, 1984, p.36).

Lack of confidence among many teachers is the result of having little experience in carrying out ecological work; hence, many have the feeling of entering the unknown (Booth, 1979). Harper (1982) agrees with Booth about lack of confidence among many teachers, but disagrees as to the cause of it. He sees lack of confidence as a rational response to the fact that ecology is a difficult subject to teach, which he argues demands an expertise which one might expect from a university lecture on ecology, but is not found as part of the knowledge base of the average high school biology teacher. Harper agrees however, that when ecology is a joint theme with physiology in a biology course, less exceptional requirements for teaching it will be demanded. Mariner (1978) suggests that biology teachers should be more aware of their responsibilities to acquire appropriate knowledge and skills in order to gain self-confidence and to hold professional respect. Hale (1986) also sees a need to recognize the lack of teacher education (especially in inservice education) be provided if the problem is to be solved.

In short, it seems that teachers with little or no ecology background, in either content or method, will likely kill any interest students may have in the study of ecology, not only in high school, but also in college.

### LACK OF APPROPRIATE FACILITIES

Many schools lack even the most simple and inexpensive equipment for carrying out ecological work (e.g., Booth, 1979; Hale, 1986)<sup>4</sup>. Towler (1980-81) found in his study of Canadian Pre-Service Training in Environmental Education, that there is a serious need for better teaching materials, as did Cox (1970) at the college level.

Field work has been recognized by many educators as one

<sup>2</sup>For example, if students get low marks on the ecological items of the exam, parents and educators might want to eliminate these questions. When these questions are eliminated, it might be reasoned that ecology be eliminated entirely.

<sup>3</sup>Including ecology as part of classroom teaching and student evaluation however, is not enough. There must be a correlation between demonstrable levels of operational thought and mastery of ecological concepts. For example, only a small fraction of high school biology students consistently demonstrate formal reasoning (Lawson & Renner, 1975; Lawson & Blake, 1976). Yet many ecological concepts taught in high school require formal operational thought in order to be understood (Igesrud & Leonard, 1988).

<sup>4</sup>Even where these learning materials do exist, however, teachers, nevertheless, may be unwilling to work with them, or to teach environmental studies effectively because they have never been trained to do so (Sutman 1980).

of the main facilities in conducting effective ecology teaching, especially when valid information about local educational sites and their organisms, easy organization of students, adequate funding, and small class size (Booth, 1979; Hale, 1986; Keown, 1986) are available. Ludwig (1985), who believes that "whole ecosystems cannot be maintained in the classroom" (p.24), suggests that the best way to teach the holistic component of the environmental system is in the ecosystem itself, in the field, or at the zoo or museum. He believes that "while the difficulty and complexity of field trip participation and learning must be considered, field trips are vital for holistic understanding of systems too large to be studied in the classroom" (p.24).

Other educators however, have found that the use of artificial or substitute environments, instead of the traditional field has proved to be a successful approach. Laboratory or artificial environments can sometimes demonstrate the same ecological principles that normally may be considered regular field work. "A compost heap, moss tuft, or rotting log close to the laboratory can often lead to just as good ecological work as can a visit to an off-shore island" (Booth, 1979, p. 264). Yet, others hold the view that ecology can be taught effectively using lecture and laboratory approaches (e.g. Cox 1970). Cruzan (1988), for example, developed an experimental ecology lab approach based on microcosms to test numerous ecological hypotheses, especially in the areas of population and community. He holds the view that such an approach has an additional advantage in being more subject to experimental control and manipulation. This approach also eliminates having to arrange field trips and, therefore is a more efficient use of time. The disadvantages however, are that other problems present themselves; for instance, microcosms don't always behave the way communities in the field do, and because of inherent time limitations, it is not always possible to collect enough data for satisfactory statistical analysis. Hale (1986), in a field-based investigation involving a combination of classroom, laboratory, and urban fieldwork, has suggested the value of the urban environment of even large cities as an integral part of ecology teaching.

#### **A PERCEIVED DICHOTOMY BETWEEN PRACTICAL AND THEORETICAL ECOLOGY**

Only a few research and course designs have been concerned with the gap between what is taught theoretically in school and what is practically attempted in the area of ecology education. Consequently, it becomes hard for teachers to combine theoretical and practical approaches. Field work, for example, which supposedly involves a practical approach to learning ecology, is usually conducted without any connection to what is being taught in the classroom (theoretical) and as a result is often a mixture of unrelated techniques which have no clear theoretical framework. For effective ecology education, we must find a balance between practical and theoretical study. To try to separate science in schools into "practical" and "theory" lessons is "...to perpetuate a dichotomy which is the antithesis of true science" (Points, Brown, and Greig, 1971, p.13).

#### **LACK OF EMPHASIS IN DEVELOPING OBSERVATION SKILLS**

In studying biology, observation is the key to stimulating the minds of pupils to think about a particular object(s) or relationship(s) in a given ecosystem. Most of all, observation is essential in the development of concrete thinking. It is the basis for the pupil's development of formal or abstract thought. It seems ironic that scientific observation is viewed as neither suitable as a subject of education nor even useful as a guide to science instruction. This seems to be the case despite the fact that, "one legitimate goal of science teaching is to promote accurate views of nature and the role of scientific investigation" Norris, 1985, p.818).

The literature suggest two views emerged in the study of observation skills. One view is that teachers are required to teach observation only indirectly because of a shortage of time: so rather than let their students look for something to observe and make their own legitimate inferences, the teachers tell them what to observe and what their observations will mean. They ask students, for example, to determine the characteristics of things, to see changes, to learn the habits of animals, etc. In observation such as this, there is no room for biased, overly subjective observation or rational disagreement between students and/or the teacher.

The other view is that observation is related to complex mental processes, and can only be accomplished through structured observational activity. Because it requires the operation of complex and elaborate mental processes, scientific observation should be represented, at least at the senior levels of schooling as a complex activity which requires planning, considerable thought, and the construction and coordination of complicated apparatus. Norris (1987) argues that:

Becoming a competent scientific observer is to achieve a complex skill, and is best achieved using an approach which proceeds from the simplest sorts of scientific observations to the more complex kinds, but at neither level portrays scientific observation as anything other than a sophisticated scientific activity. (p.832)

Hill (1985; 1986) extends this argument and contends that if observation of the living world is carried on without a structured method, it will be a sterile educational activity.

Whether it happens informally or as a structured activity, the literature cited above shows that the role of observation in teaching science, and particularly ecology, has not gained adequate emphasis from either curriculum planners or teachers.

#### **Part Two**

Twenty-four biology teachers were interviewed as a part of a larger study (Cherif, 1989) regarding both literature views and their views of what could prevent biology teachers from teaching biology effectively. The participants had been teaching biology on an average of more than seven years at the secondary school level and had more than twelve years of instruc-

**Table 1**  
**Teachers' views of what could prevent secondary school biology teachers from teaching ecology effectively**

No. Reasons / Factors	Number of Participants					Total
	Agree	Mildly Agree	Neutral	Mildly Disagree	Disagree	
The nature of ecology	7	1	2	-	10	20
Confusion about how to teach ecology.	6	5	-	1	8	20
Lack of appropriate samples of examination syllabuses and papers.	7	1	1	2	9	20
Lack of teacher confidence in dealing with ecological issues and in identifying local flora and fauna.	12	3	-	-	5	20
A shortage of appropriate facilities and inexpensive equipment.	3	-	2	1	14	20
A perceived dichotomy between practical and theoretical ecology.	10	2	3	-	5	20
Lack of emphasis on observation in science education.	3	1	10	-	6	20

tional teaching experience in British Columbia. Table 1 summarizes the views of the interviewed teachers as to what could prevent them from teaching ecology effectively in secondary school biology.<sup>6</sup>

#### DATA ANALYSIS AND SUMMARY OF THE FINDINGS

Data analysis shows that the secondary school biology teachers in the Lower Mainland in British Columbia who participated in this study were almost equally divided (within +/-3) on the effect of the nature of the subject, difficulties and confusion about how to teach ecology, and the lack of appropriate samples of examination syllabuses and papers. In this study no correlation was found with these three particular observations from Booth's study. However, we made three main observations here: first, it seems that none of the teachers thought of the nature of ecology as a problem until asked about it. Their reasons were very closely tied to the nature of the educational system, time-clock, funding, or of the teacher's experience in ecology, rather than the nature of ecology itself. Second, those teachers who thought teachers faced difficulties thought that the problems stemmed from insufficient ecological background (7 teachers) and/or an outdated teaching style (8 teachers). Third, only a few reasons were given by participants to justify their answers regarding this question of lack of appropriate samples of examination syllabuses and papers.

The majority of the participants, on the other hand, appeared to agree with Booth's study regarding the lack of teacher confidence in teaching ecology and in identifying local flora and fauna (15 agreed/5 disagreed). They did not see, however, the shortage of appropriate facilities and equipment (15 disagreed/3 agreed) as a problem. The majority of the participants also perceived a dichotomy between the practical and theoretical aspects of ecology in teaching as one of the main factors that might prevent secondary school teachers from teaching ecology effectively. Regarding the lack of emphasis on observation in science education in general, and ecology in particular, half of the participants (10 teachers) seemed unaware of its effect on teaching ecology. Yet, they were almost equally divided (4 agreed/6 disagreed) on whether to perceive it as a problem.

#### OTHER REASONS THAT MIGHT PREVENT EFFECTIVE ECOLOGY TEACHING

B.C. biology teachers who participated in this study, pointed to three potential problem areas which might prevent teachers from effectively teaching ecology, which were not addressed in the literature review. Those problems were: (1) insufficient teacher education (pre-service and in-service) in teaching ecology; (2) The nature of the present educational system; (3) The absence of ecology in the core section of the curriculum or as a mandatory topic.

<sup>6</sup>A complete descriptive of the interviews and the whole result of data analysis can be found in Cherif's work (1989).

## **INSUFFICIENT TEACHER EDUCATION (PRE-SERVICE AND IN-SERVICE) IN TEACHING ECOLOGY**

Ten of fifteen participants argued that ecology education for teachers doesn't exist in B.C. Two teachers weren't sure and three thought it was rare and/or without follow up, or only existed at the elementary school level as ecology workshops. One teacher thought, that even if in-service ecology education exists, teachers usually do not attend because they are over-worked and there is not sufficient money available to pay for release time.

To quote one of the respondents who wanted to learn process not content in inservice education:

There is none in ecology. But there are a lot of things you can take outside of the school district which are not in inservice education in the district. A lot of the in-service education programs teach concepts teachers already have . . . Teachers themselves know most of the ecological concepts, but what they need is what they can do in the classroom to teach a particular ecology subject. They also need papers, materials, and other things.

In summary, most of the teachers claimed that there is either no inservice or preservice education, or what there is, is insufficient and ineffective. They also expressed the view that teacher ecology education is important, especially for those teaching biology or ecology with no background in either of those areas.

## **THE NATURE OF THE PRESENT EDUCATIONAL SYSTEM.**

Five participants mentioned twelve times (directly or indirectly) the problems involving the nature of the educational system. Those participants asserted that the present educational system is not conducive to effective ecology teaching because it does not provide the flexibility or the time necessary for field work, long-term projects, research and investigation, or lab work. Most participants felt that many teachers aim toward the governmental and scholarship exams (which do not include ecology questions), and that that focus hinders their teaching.

## **THE ABSENCE OF ECOLOGY IN THE CORE SECTION OF THE CURRICULUM AND AS A COMPULSORY TOPIC.**

Some of the respondents claimed that because ecology is not a core or compulsory topic, it is not being taught. They said that in the 1974 biology 11 & 12 curriculum, ecology comprised 20%-30% of the core, and even then many teachers omitted it in their teaching. So now, when it is an optional unit in the 1986 biology 11 & 12 curriculum, it is not getting the attention it merits, even if teachers want to teach it. According to McClaren (1987), while environmental themes and topics do appear in the mandated or prescribed curriculum in B.C. Canada, "there is no course, or even a course unit or topic within the entire provincial curriculum (in B.C.) that is actually titled "Environmental Education" (p. 15).

## **DISCUSSION**

While most teachers seem to be aware that the highly

effective methods of teaching ecology and environmental topics are those which involve students as active rather than as passive participants, the literature suggest that in teaching ecology and environmental topics secondary school biology teachers frequently used lecture, discussion, work sheets, and textbook assignments. The gap between the practical and theoretical, as well as the lack of emphasis on observation in science education have been perceived as additional factors.

Data analysis in this study shows that while the secondary school biology teachers who participated agree with some and disagree with other reasons provided by the literature, they hold additional views on what might prevent secondary school biology teachers from teaching ecology effectively.

Rather than the seven reasons in table 1, it might be three reasons which were provided by the participants in this study-insufficient teacher education, the nature of the present educational system, and the absence of ecology in the core section of the curriculum or as a compulsory topic-which seem most significant in relation to understanding problems in teaching ecology. It is obvious that the lack of sufficient teacher education will lead to unqualified teachers, not only in the teaching of a given subject but also in developing teaching aids and curriculum materials necessary for effective ecology teaching. It should be understood, however, that exposing biology teachers to ecology only in their preservice education is not enough to gain and maintain confidence and professional growth in teaching ecology without ongoing inservice ecology education and visa versa. Inservice ecology education is needed to increase teacher confidence and to develop professional interested growth.

In addition to teaching ecology, the absence of ecology in the core section of the curriculum and as a compulsory topic potentially results in schooling where only environmentally oriented teachers integrate ecology into their biology courses, or select ecology as an optional part of the curriculum if there is enough time. Related to this is the absence of ecological questions in the provincial exam for secondary school science students. As both Eichler (1977) and Booth (1979) pointed out, unless ecological questions are integrated in student exams, it is unlikely that attention will be given to the subject. Yet, including ecology in the final exams is not enough without teaching ecology effectively.

Ecology and/or environmental study, whether as a discipline or a subject, is a new branch of knowledge in the present educational system. While ecology by its nature is a holistic, multi-disciplinary, and field-oriented study that requires a diverse approach, the present educational system, with its time-limited-class system is not suitable for teaching ecology and environmental study.

In conclusion, secondary school biology teachers who participated in this study speak of the ineffectiveness of ecology teaching in many biology classes and the reasons for its ineffectiveness. While they recognize the importance or teacher confidence in teaching ecology and securing a balance between practical and theoretical aspects of ecology, they point out major obstacles to effective teaching.

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