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## **Interdisciplinary Approaches in Environmental Education**



Division of Science, Technical  
and Environmental Education

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## PREFACE

The international and regional meetings organized since 1975 in the context of the Unesco-UNEP International Environmental Education Programme, especially the Intergovernmental Conference on Environmental Education (Tbilisi, USSR, 1977), have underlined the importance of providing personnel responsible at different educational levels with orientations and instruments stimulating the development of an interdisciplinary pedagogical approach toward the solution of concrete environmental problems.

In this perspective, the present study on interdisciplinary approaches in environmental education outlines current thinking about this very special teaching problem, as well as several general pedagogical approaches enabling an interdisciplinary implementation of educational activities.

The study does not aim at being exhaustive but, rather, at stimulating those -- researchers, inspectors, trainers -- whose duty it is to develop and stimulate teaching activities, as well as those -- teachers at all levels and in all disciplines -- whose role it is to conduct them with consideration of the whole range of possibilities.

Their choices will not, however, follow simply from reading this report. These choices must be discussed and adapted to specific countries, regions, means and, especially, to the learners involved. There is no single pedagogical practice valid for every phase of schooling, every student and every country even if one is working toward a specific educational objective. This depends on a considerable number of parameters, not always easy to determine. The teacher in his or her classroom, or a team of teachers, is most favourably placed to determine the best possible methods to use, on the condition that the teacher or team be sufficiently informed to effectively analyze the teaching situation and that adaptable pedagogical possibilities be available.

Although this report is based on what has been published internationally, it should be augmented and remodeled according to latest developments in various countries.

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PART ONE : ANALYSIS OF AND APPROACH TO THE CONCEPT OF INTERDISCIPLINARITY

Environmental education "is not to be added to educational programs as a separate discipline or a subject for special study, but as a dimension to be integrated into them. Environmental education is the result of a reorientation and rearticulation of the various disciplines and of various educational experiments (natural sciences, social sciences, arts and letters, etc.) providing an integrated perception of the environment and fostering more rational environmental action replying appropriately to social needs."

Unesco - Tbilisi Intergovernmental Conference  
on Environmental Education, 1977

Chapter 1 - SOMES DIFFICULTIES ENCOUNTERED IN AN OVERALL APPROACH  
TO THE ENVIRONMENT

Can we avoid a misconstruction that would lead environmental education into another blind alley in terms of people-nature relationships?

After treating nature in the past as an enemy to be "broken, vanquished and dominated", we are now too often presented with a "victimized" biosphere that must be protected, preserved, safeguarded and helped to survive. Neither of these attitudes enables us to pose environmental problems and solve them correctly.

The biosphere in itself does not need to be protected. It is our place in nature that is threatened by our disregard and our refusal to take account of how the natural systems function in which we produce and consume. The survival of humanity, the dominant element in these systems, necessarily depends on the maintenance of nature in a state that supports human life. But are all ways good to sensitize people to these environmental problems? Might not some of them block or even falsify the necessary global approach? Only recently, as part of the national campaigns for "great causes", a French television programme showed a forest burning and brought us its "cry" of anguish, which was supposed to be intolerable. We must urge that these facile effects be set aside; it is not our sensibility, our affectivity, our emotional capacity that should be appealed to in such cases, but, more fundamentally, our instinct for self-preservation, our intelligence and imagination. What must be developed is our ability to reason through complex situations over the medium and long terms. And this must be done through an approach that is no longer sectorial or haphazard, but which reintegrates the individual, his actions and their consequences on the environment in which they develop.

Building homes or a factory, working a forest, a quarry, a field, planning a road, disposing of rubbish or waste water -- all these necessary everyday acts are performed with economic profitability in mind and -- we now know -- without adequate analysis of the character, possibilities and limitations of the affected environment. Such ill-prepared acts usually lead to two kinds of harmful consequences. First, the environment is not used to the limit of its possibilities; it is a mere support, and users do not benefit from the system that is ecologically most appropriate and, hence, most effective according to current knowledge. Second, this under-utilization is compounded by the negative medium- or long-term impact of steps taken without sufficient preparatory analysis; or analysis may be made and the results ignored. How can such waste, such mistakes be avoided? Should those who do such things be made to feel guilty? This would be hard to do and, even if it were done, would probably turn out to be insufficient and could have hazardous consequences. By making those responsible pay for the harm and damage they do? But who is really responsible? The principle of "the polluter pays" is applied in some countries; the results show that legal and economic measures taken in such situations do not stop the activity under attack; moreover, responsibility is bucked down the line when the cost of the fine is passed on. Production and consumption take place in specific socio-economic contexts; if the environmentalist approach to their impact on the environment consists solely of penalizing harmful activities, it will achieve only partial and random solutions that are suspended whenever economic conditions so require.

Only an overall approach to environmental problems can spare us these wasted motions and legal and economic bottlenecks. But if mere knowledge of environmental problems is inadequate to combat them, and if we admit that the process that gives rise to the problems must be changed, then we can better imagine the difficulties to be overcome (given our thinking habits and the weight of economic systems) in finding coherent and lasting solutions.

Even so, we must avoid the pitfall of viewing this global approach to the environment as a new morality imposed like the rigid dogma of a new religion. Fortunately, as much research has already shown, the approach has other bases and arguments to recommend it.

Environmental education takes on its full meaning in these difficult contexts. It is the only safe and sane way to prepare for the changes that educators, teachers and laymen of the future will want to see happen.

One of its first objectives is to show the effectiveness of a global approach to the environment by making clear that (unlike sectorial approaches) it is not an extra constraint imposed by privileged social groups, to their profit, on those less favored. Rather, it is a possibility of change opened up by a new area of knowledge and by analytical tools that are more appropriate to the problems we face.



Chapter 2 - COMPLEXITY OF AN OVERALL INTERDISCIPLINARY APPROACH  
TO THE ENVIRONMENT

Whatever the problem tackled and the scale of apprehension adopted, the analysis to be made is extremely complex because of the many aspects (economic, legal, social, political, geographic, historical, biological, chemical, physical, etc.) that must be included to understand:

- a) how the human activity under examination functions in terms of the environment ;
- b) what the key points are at which action should be taken to alter the prejudicial results of the activity in question ;
- c) what type of action would be desirable and possible, by whom, how, etc. ;
- d) what consequences in the short, medium and long terms are foreseeable, and in what areas.

This complexity of aspects is increased by manifold but variable interconnections in time and space. However shrewd an analysis may be, it will inevitably be imperfect. But to reduce the margin of error to a minimum, help is needed from experts in the different disciplines involved.

Pluridisciplinarity alone does not solve the problem posed because each expert is trained to supply a limited but self-contained response in his own field. Therefore, although pluridisciplinarity juxtaposes analyses and solutions, the overall results obtained will not necessarily be coherent and viable.

Despite the possibility of group discussions and the designation of work teams, all the elements are never integrated because they are too unequal in value and level. Thus, the experts' limited responses are transformed into a global response only to the detriment of some other contribution; this too often results from fashions, from the weight attributed to each of the disciplines involved or to the more or less forceful personalities of the persons engaged in the research.

It is by the use of a common, cooperatively built tool that makes the disciplines' contributions operational that these drawbacks can be remedied.

The common objective is as complete an understanding as possible of the systems in which human activity functions so as to pinpoint its effects on the environment. Beginning with that objective, the common tool or analytic grid is built with a systemic focus through integration of parts of the different systems (ecological, social, etc.) engendered by this activity. This is done in three phases:

- a) Determination of the system's elements and the laws regulating their interaction, preferably in quantitative form, but at least in qualitative form.
- b) Then, determination of the system's evolution and, specifically, prediction of the consequences on that evolution of changes made in the system.

- c) Finally, with an objective set that takes political and economic choices into account, the best solutions are chosen -- those least harmful to the environment -- to the actions imposed by the achievement of that objective. (1)

This systemic approach is pluridisciplinarity's sure road to interdisciplinarity. If applied over a long period of time with the same participants, it can even attain the transdisciplinarity so necessary to research.

Transdisciplinarity is seldom reached because it requires a considerable investment of time by a researcher seeking to practice it, a mind constantly open to other discipline and a large dose of humility. Since, in addition, transdisciplinarity becomes "profitable" only very slowly, after a painful period of reexamination of each participant's concepts and methods, we can understand that many technical as well as psychological reasons impede its development.

Interdisciplinary research in an environmental framework aims at developing new knowledge that will supply the means to solve certain problems. Environmental education is not so ambitious, but it also relies on interdisciplinarity among teachers to reach its objectives.

Whatever the methods and intensity applied to training teachers, what must always be put across is an understanding of a system's mechanisms as they reveal the relationships between human activity and the environment. A systemic approach, therefore, is indispensable even for observing and describing known processes. Moreover, this approach is in itself an element in the training to be acquired if the desired changes in attitude, behaviour and, especially, thought mechanisms are to be achieved.

Concretely, in teaching, whether a single teacher is responsible for several subjects or a number of teachers work in more or less narrow disciplinary specialities, two conditions are essential to realizing interdisciplinarity; first, knowing with sufficient precision what a given discipline can bring to environmental education and which of its aspects deserve to be further developed within an environmental education framework; second, assuring the connections between disciplines that by definition characterize interdisciplinarity. In practice, these connections will probably require preliminary theoretical thinking before they can be established, but they will relate to concrete subjects of study as soon as the systemic approach is sufficiently evident. If several specialized teachers participate, interdisciplinarity will require organization of a team; its constitution obviously depends on the human relationships that emerge.

A major difficulty in achieving interdisciplinarity can stem from the teaching practices peculiar to each subject; the specificity of fields of study often makes for considerable autonomy in their teaching. To participate fully in environmental education, teachers must consent to teach in a different style than is traditional in their subjects

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(1) "Problèmes posés par certains aspects de l'enseignement de l'environnement" by Jean-Marie ABILLON in "L'enseignement de l'environnement au niveau universitaire : réflexions et données" - O.E.C.D.

(example: mathematics will not only be presented as a contribution to logic, but also as applied mathematics). It is generally admitted that so-called active methods are more judiciously and more easily applied to environmental education.

Interdisciplinarity in environmental education requires inclusion of the various disciplines (it is easy to show that they should all participate), but their respective roles will be different, especially quantitatively, for they will not all participate all the time.

### Chapter 3 - CLARIFICATION OF THE CONCEPT OF INTERDISCIPLINARITY

#### 1. Present situation

If we try to analyze the present state of the concept of interdisciplinarity as it is practiced in education, we find it is difficult to define its status or extent clearly. But to a very considerable degree, its application is still limited.

##### 1.1 Absence of a clear status

Ambiguity appears immediately in the multitude of synonyms for interdisciplinarity. Authors will use the words

- pluridisciplinarity
- multidisciplinarity
- transdisciplinarity
- polydisciplinarity

to mean the same thing in the same article. Qualifiers take a variety of forms. Interdisciplinarity has been qualified as linear, structural, restrictive, instrumental, academic, syncretic, epistemological, heuristic, polyclinical (1), etc. Connotations differ according to schools of thought and even to subject matter, not to speak of the authors' changing notions.

Schematically, it is possible to distinguish between :

- a) pluridisciplinarity, which merely brings in several disciplines, often going no further than to juxtapose them;
- b) interdisciplinarity, which assumes a good knowledge of each other's concepts between the disciplines concerned and is based essentially on a systems approach;
- c) transdisciplinarity, even more ambitious, which assumes conceptual unification between disciplines.

What can be said is that a new pedagogical mode has risen on the horizon of primary and secondary school education: interdisciplinarity. But the only definition to be drawn from all the initiatives being taken can be stated this way :

INTERDISCIPLINARY TEACHING IS TEACHING IN WHICH TWO OR MORE DISCIPLINES ARE EXPRESSED IN TERMS OF INTERRELATIONSHIPS.

This definition is so general, however, given the multiplicity of approaches to the problem, that it leaves many questions unanswered. A first group of questions bears on the nature of the concept :

- What are the possible relationships among the disciplines?
- Are they biunivocal or systemic ?
- What are the investigative techniques, etc.?

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(1) If we limit ourselves to the French and English terms only.

A second group is based more pragmatically on concrete translation of the process into active teaching:

How are the disciplines coordinated in time? In space?  
What is each teacher's role?  
Does this require changes in teacher's time schedules, in their pedagogical training, etc.?

Why this pedagogical enthusiasm? It seems to us to stem from two complementary reasons. On the one hand, teachers are confronted with new generations of students, disconcerting students. On the other, they are faced with so many fields, so steady an extension of knowledge, and with competition from the mass media, that they no longer know what knowledge to transmit or how to transmit it. From this follows a need "to seek to end (their) isolation" (1).

A first attempt to do this was made by reinforcing disciplinary connections. This was a feature of innovations in mathematics and science during the 1960s and '70s. The experiments provided greater mastery of new data and led to efforts to define the essential elements of the knowledge to be transmitted. "The search for security in teams and, through them, a guaranty... prompted by the lack of assimilated, circumscribed teaching areas, most certainly explains the spontaneous or stimulated formation of disciplinary teams" (1).

These attempts soon proved limited, however. The disciplinary teams were not adequate to respond to the problems of education as a whole. Disciplinary innovations generally failed to attain their objectives because students, when they were not working in an interdisciplinary context, remained in a classic or completely divergent context. Moreover, complication of the disciplines themselves, the innovations temporarily affecting them, created new distortions that could no longer be masked. Gaps appeared within each discipline that seemed to need filling by allied disciplines.

This trend toward awareness has been more accentuated since educators began paying attention to students. Evaluation of acquired knowledge consistently showed the distance between the learning achieved and the objectives sought.

To complete this summary, we must also stress the increasingly widening abyss between programmes, teaching and the student bodies at which they are aimed. More and more, learners also exist through their rejection of schooling; many students refuse to "play the game" when faced with a juxtaposition of disciplines, each with its own progression, goals and structure that leave no room either for the learners' motivations or concerns about the environment in which they are plunged.

Hence the search for new contacts with a view to promoting intellectual if not educational coherence: the search for interdisciplinary teaching strategies.

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(1) LEGRAND, L., "L'interdisciplinarité en pédagogie", Bulletin de liaison, Rapport des journées d'Albé-ville, April 1979; National Institute for Educational Research - Institut national de recherche pédagogique (INRP), Paris, 1979.

## 1.2 Relative importance of the word

"Interdisciplinarity" has been launched as a word, if not as a concept. It crops up in ministerial circulars and instructions in many countries. Sometimes they even attach value to it. But in the reality of the classroom, its qualitative and quantitative importance is still slight.

Today, in educational practise, interdisciplinarity is mainly confined to groups of teachers using new teaching methods, stimulated toward innovation and who are constantly devising projects despite all sorts of obstacles. But this affects only a few circles. Although several efforts have been made and encouraged by local authorities at the the institutional level, the experimental phase has not been followed by general extension to the school system. Thus, even in the case of environmental education, where interdisciplinarity is a necessity, attempts have remained at this experimental stage in spite of the means made available and the competence of teachers involved.

Qualitatively, it is still very incomplete, very tentative, in any case as regards the objectives postulated for the experimental projects. We can call it "juxtadisciplinarity". It generally takes the form of organizing a theme (the function of a forest or the study of a rural village). An aspect is studied in each discipline: in history, the teacher will make a study of the forest's origin; in geography, attention will focus on the production and use of wood; in biology, on food chains; in chemistry, on the combustion and transformation of wood; in literature, on writers inspired by the forest; mathematics students will calculate heights; in the visual arts, they will draw leaves; in physical education, they will run through the forest or hurl tree trunks; in handicrafts, they will build bird shelters, etc. This type of interdisciplinarity is usually limited to three or four disciplines.

In the case of rural villages, the distribution is much the same, with the community's history studies in history class, its resources and products in geography, books in the native language, drawings of houses in the art classes, perhaps mock-ups in handicrafts, etc. The biology teacher might manage to get in a little hygiene or the fight against disease, but the physics and chemistry teachers find it difficult to take part.

Within this approach of interdisciplinarity, each discipline will at best bring to the study its vocabulary, its approach, its progression independently of the others and, more often than not, in contradiction to them (1). It might even be said that each discipline tries to find a place for part of its own programme. In the best of cases, the teachers meet and try to pick out the point or points on which to concentrate. Then, separately, they decide on a series of exercises, the parts of their courses on which they can focus to respond most amply to the chosen theme. As the project develops, each teacher will make a few references, a few allusions to the areas his colleagues will deal with -- at least in the disciplines whose vocabulary he still understands. Sometimes teachers ask their students to ask the other teachers questions. An assessment may be made, but evaluation will be based on whether "it worked" or "it didn't work", whether the students "were or were not satisfied".

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(1) A word can vary in meaning with the disciplines (such as genetic in biology and psychology), techniques can vary (the types of graphs used in physics, mathematics, geography and biology) and so can measurements (calories in biology and physics).

To solve environmental problems, however, certain political, economic, social and ecological imperatives must be identified, arranged in order of importance and related in a process of national development planning. Properly, there should be an awareness of the correlations existing among phenomena and situations that the unidisciplinary approach tends to fragment.

The interdisciplinary approach to environmental problems first of all implies consideration of the system in which the aspect of reality constituting a problem occurs. To explain a phenomenon, an overall frame of reference must be established that incorporates the particular contribution of each discipline and demonstrates their interdependence.

In education more than in any other field, if this is possible, the weight of tradition is a powerful brake on necessary change. The weight of history remains when the men who made it are gone, and the unfortunate compartmentalization of government holds firm against all onslaughts with the strength of habit and ways of thinking carefully maintained year after year. Disciplinary structure is an example of this.

Tradition is not limited to structures alone. It largely inspires the very spirit of teaching. Concepts outmoded by scientific, technical, demographic and social change, condemned by epistemology and psychology, live on and, though educators are unaware of it, continue to inspire the goals and procedures of the old style of teaching, for these were the concepts in circulation when today's teachers were trained.

A clear consciousness of this conditioning, it seems to us, could open the way to better adaptation of education to the new demands of the world we live in. We believe that a new kind of teacher training, infused with a spirit of research, could inspire desirable innovations in educational systems (1).

## 2. Prospectives for interdisciplinarity in environmental education

What, then, might be the concept of interdisciplinarity as applied to environmental education? There can be no question here of giving solutions to the problem, because they have not yet been found, but several points do exist in which to anchor thinking on the subject and, especially, to test new pedagogical alternatives.

First of all, what are the goals of interdisciplinarity in environmental education? In terms of conceptual structure, articulation of the disciplines must be improved for the study of environmental problems; still more important is the need to better adjust the disciplines to students' learning needs. Note, however, that it is the learners' needs that are preponderant; it is their attitudes that must be changed to make them more positive toward the environment. And it is they who must acquire the heuristic methods and concepts needed to control the environment and its development. This done, the disciplines' need for material from allied subjects follows from the need for coherence in learning.

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(1) GIORDAN, A., Une pédagogie pour les sciences expérimentales, Centurion, Paris, 1978.

## 2.1 Interdisciplinarity as a response to environmental problems (1)

Any object of study is, finally, a support for an interdisciplinary study insofar as a scientific fact is always an abstraction from a real complex, and insofar as that abstraction necessarily marks out a circumscribed area corresponding to a particular inquiry, specific in its approach, its method, its epistemological presumptions... In fact, all disciplines need allied subjects: physics needs mathematics, biology needs physics and chemistry. Mathematics is most frequently used as an abstract instrument of calculation or logic for other disciplines. Similarly, all disciplines need an indigenous language as a supportive instrument.

This is even more valuable in dealing with environmental problems in which a phenomenon must be studied through different but complementary approaches. This is the case, for example, with urbanism, on which converge such different disciplines as sociology, demography, psychology, architecture applied physics, esthetics. The technique is equally valid in studying pollution, which involves not only biology, physics and chemistry, but also technique, economics, even sociology and politics, if for example, the closing of a plant would create massive unemployment in an economically fragile region, or if installation of an antipollution system made a product non-competitive with foreign goods.

In all environmental studies, the contributions of all the disciplines converge to reveal the phenomena and problematic situations. A mono-disciplinary approach tends to fragment these correlations.

## 2.2 Interdisciplinarity as a response to the needs of student education (2)

Classic disciplines, as we have seen, are inadequate to reach the general objectives that are indispensable in training people and are recognized as such in official programmes. This is also true within the framework of environmental education, the goal of which is to enable people to understand the complex nature of the environment as it results from the interaction of biological, physical, social, economic and cultural elements. So assimilated, it should provide individuals and groups with the means to interpret the interdependency in space and time of these elements so as to foster more thoughtful and prudent utilization of universal resources for the satisfaction of humanity's needs. (3)

Moreover, such an education should contribute to awareness of the environment's importance in economic, social and cultural development. To this end, education should disseminate information about patterns of development that would not harm the environment, and should promote the adoption of life styles that are in more harmonious rapport with the environment.

Finally, environmental education should arouse a clear awareness of economic, political, and ecological interdependencies in the modern world, in which the decisions and behaviour of every country can have international consequences. In this sense, environmental education plays the very important

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- (1) GIORDAN, A. et al., Vers une éducation relative à l'environnement, INRP, Ministry of Education, Paris, 1976.
  - (2) GIORDAN, A. et al., Recherche pilote, INRP-Unesco, Paris, 1979.
  - (3) Final report of the Tbilisi Conference, Unesco, 1977.



role of developing a sense of responsibility and solidarity among countries and regions, independently of their stage of development, as the foundation of an international order that would assure the conservation and improvement of the human environment. This is the goal at which international cooperation to develop environmental education should aim.

The ends indicated above constitute the goals of a unified educational practice. If what is wanted is a global approach to the environment, educational programmes aiming at a fragmentary or partial realization of some of these objectives are vain and ineffective. All environmental education programmes should contribute to both development of knowledge and to acquisition of the attitudes and skills needed for the preservation and amelioration of that environment's quality.

Realization of these ends implies that the educational process will dispense knowledge, teach methods and implant the attitudes and values that contribute to understanding and solving environmental problems.

As regards knowledge, such an education should provide, in degrees of specificity and precision varying with the audience, the means to understand the relationships of the physical, biological, social and economic factors in the environment, as well as their evolution in time and modifications in space. This knowledge should lead to behavioural changes and to action to protect and improve the environment; it should be acquired through attempts at structuration based on observation, analysis and practical experience of a given environment.

As for value, environmental education should stress the various options available in development, keeping in mind the need to improve the environment

From this follows the indispensable creation of pedagogical situations that depend on no specific discipline and do not require a discipline. In present educational contexts, and while awaiting the gradual evolution of these systems, it is the teachers of the various disciplines who must impart the interdisciplinary objectives necessary to safeguard and develop the environment. Awareness of these interdisciplinary objectives, in fact, alters teaching in the disciplines, especially by developing group and individual activities leading, notably, to behaviour and actions corresponding with the general objectives.

Disciplinary programmes, however, generally follow an internal logic, that is, notions are linked according to a rational order. This order is valid for an adult expert in the discipline, someone whose knowledge and frame of reference are very much oriented by a host of allied studies. This is not true for students. In the case of environment, which is a total and unified world, entry into it implies, among other things, a certain degree of mental development, a certain frame of reference, a certain approach to problems. So must it be for a young student who approaches the environment, tackling spatial or temporal structure, access to symbolic thought and hypothetical-deductive methods.

The problem is the same for adults without environmental awareness; their frame of reference is also incomplete because they have not, for example, mastered the vocabulary and instrumentation of architecture, an ecologist's systemic approach, etc. It is useless to try to instill the

fundamental rules of an ecosystem's equilibrium in a ten-year-old pupil or an uninitiated adult if they are still incapable of structurizing space. Similarly, it is impossible to confront a youngster of 15 or 16 with an analysis of system if he is not yet able to establish combinative structures. This does not eliminate the need to deal with complex problems in class. On the contrary, this should be done. But the teacher must be keenly aware of the obstacles blocking a student's access to knowledge and must choose his pedagogic methods in terms of these difficulties.

In short, let us say that intellectual constructions depend on already acquired knowledge, on overcoming epistemological obstacles with the aid of other disciplines, instrumental disciplines -- mathematics, indigenous language -- but also, in regard to environmental education, through physical culture, skill in group activity, in the visual arts, to cite only a few examples.

Interdisciplinarity here is an instrumental necessity. It facilitates construction of knowledge both directly and indirectly as an aid to preliminary formation of a basic personality.

Interdisciplinarity also offers an approach to complex activities and problems that, given their conception, cannot emerge from a "rationally" constructed disciplinary curriculum. The centers of interest pinpointed by environmental studies -- pollution, environmental nuisances, atea development, etc. -- are either inaccessible through strict disciplinary exposition or require a complex of disciplinary knowledge that students do not possess. For the subjects and activities that interest, even excite, youngsters are always complex subjects and activities that are not the province of classic curriculum. Disciplinary programmes are, in fact, very far from the interests of most learners, who are caught up in a cultural environment very different from their school and who are very much influenced by the media. Here, too, an interdisciplinary approach can build a foundation of useful knowledge on learners' preoccupations and motivations.

### 3. Characteristics for an environmental education interdisciplinary approach

Without sacrificing the existence and individuality of each classic discipline, there is a preliminary need to soften their overly analytical character, their very marked differences arising from their individual concerns and their different methodologies, because all this is difficult for the learner to understand and offers poor motivation for him. Ignoring boundaries, interdisciplinary environmental education is concerned to give a more global, less schematic view centered on environmental problems; more important, it stresses analysis as a vehicle for alternative solutions.

Resulting solutions are varied and complementary. The first requirement is to introduce into each discipline the environmental dimension(s) needed to cover the general objectives not programmed by traditional disciplines: ecology in the natural sciences, economics and sociology in the social sciences, architecture, urbanism, techniques of expression in the indigenous language, visual arts, cybernetics in mathematics, and so forth. It is abnormal that knowledge so vital to understanding the contemporary world should still be excluded from standard curricula.

If the concern is to avoid excessively increasing the number of disciplines, such interdisciplinary approaches would be a first step toward introducing the subjects into school systems. The curricula of the various disciplines, especially the basic disciplines, must also be harmonized by allowing construction of concepts and the acquisition of suitable methods by a process of interplay among the disciplines.

Teams must also be organized from the disciplines to work with learners for the study of concrete problems rooted in the reality around the school. The teams' concern will be to create an "interdisciplinary state of mind", that is, a context in which the disciplines no longer haughtily ignore each other, but try to work together as often as possible, either to deal with intermediate areas or to create learning situations that can motivate students and lead them to make a positive affective investment in their school tasks.

Moreover, it is necessary to coordinate the programmes of the different disciplines so as to allow the basic disciplines in particular to fully play their part in a timely way, as well as to stimulate the development of concepts or the acquisition of new methods through an interplay between the disciplines.

What is important is to develop an interdisciplinary, project-oriented pedagogy aimed at a specific environmental action. When this is done, the traditional disciplines no longer exist in themselves, that is, they are no longer taught in terms of their own objectives, following their own progressions based on their internal rationality; they become indispensable instruments for realizing the project. The point of departure is no longer the discipline, but an educational project comprising an action concerning an environmental problem and the proposal of alternative solutions to it that will lead to environmental management of an area and to a sought-for body of educational objectives.

The individual disciplines then enter not merely to teach their own language or to develop their own particular objectives, but to contribute the means (concepts, methods, techniques) of understanding the problem or system. In other words, in keeping with the project's inherent needs the disciplines unite their efforts to study a given phenomenon through different but complementary approaches.

The fact that this interdisciplinarity is oriented toward the solution of precise problems arising in the students' lived experience gives it a better chance to break through disciplinary compartmentalization.

The purpose of such a system is to make people everywhere, at whatever level, aware of the problems blocking individual and collective well-being to elucidate the causes and determine suitable means to solve them. Individuals can thus participate in a collective definition of the strategies and actions which can solve problems touching on the quality of the environment.

If there are many environmental problems today, it is partly because very few people have been prepared to correctly analyze and effectively solve concrete, complex problems. Overly abstract, overly compartmentalized

education has ill-prepared people to face the changing complexity of reality.

From this point of view, even science teaching is limited, for a given organization of information is valid only within a clearly determined field. Ill prepared to recognize this, faced with a reality that never responds to the application of fragmentary knowledge, people do not always succeed in solving problems and so tend to retreat into irrationality. Environmental problems are indeed complex. They bring a great many parameters and interrelationships into play. Lack of information and approaches leads people to defer to the experts when difficulties arise. With recourse to technocracy thus often justified, those responsible no longer bother to enlist people's participation because they are thought of merely as executants or consumers.

Education centered on concrete environmental problems implies, conversely, that the various aspects of knowledge coalesce to provide explanations of complex realities. It is important, therefore, that educational structures seek as often as possible to get people to take part in organizing their own learning and to give them the opportunity to make decisions about environmental problems. These structures should establish a special relationship encompassing sensitization to the environment, the acquisition of data, the ability to solve problems, clarification of values and direct or indirect participation within the community in protecting and improving the environment.

To give new relevance and effectiveness to educational processes, environmental education must escape two pitfalls. First, it must abandon the classic pedagogical conception centered on pre-established notions transmitted either directly in the form of lectures or indirectly as a dialogue implying too much passivity in the learners. Moreover, the often fragmented and compartmentalized knowledge in a particular discipline should not be presented in terms of the teacher's intellectual habits, but should take account of the modes of thought of children, adolescents and even uninstructed adults. Second, the disadvantages of purely informative teaching should be avoided. Education must, of course, inform, but pure information alone does not constitute an adequate education, which is not merely the sum of a series of data. While information plays an important role in sensitizing the public, it cannot properly teach people how to solve problems. Environmental education, then, should not be limited to disseminating new information, but should help the public reexamine its mistaken ideas on environmental problems and on the value systems to which these ideas belong.

Environmental education should be critical, so as to foster close analysis and the inclusion of the many factors entering into a situation. Similarly, it should stimulate creativity, so as to facilitate discovery of new analytical methods or combinations of methods producing new solutions. This creativity should be constantly controlled by critical analysis to avoid falling into Utopianism, but critical analysis alone is powerless to find solutions.

Besides, since environmental conditions are more the result of social, political, economic and technological decisions than of physical constraints,

environmental education should aim at establishing a new system of values. All decisions relating to social development and the improved well-being of individuals are most often based on implicit considerations of what is useful, good, beautiful, etc. An educated person should be able to ask himself such question as: "Who made this decision? On what basis? With what immediate goals? Were the long-term effects evaluated?" In short, he should be in a position to know what decisions were made and on what values they were based. Values and decisions are the organizing principles of action.

For all activities in environmental education, teachers and learners should have a strategy that enables them at the outset to place themselves in a situation that is really related to environmental problems. They should be able rapidly to choose the themes and the environment to study so that the functions of its components and their interrelationships, presenting the results, working out proposals and even taking concrete action can proceed within the institutional teaching framework in the time available. The yoke of formal pedagogical methods often imposed on the disciplines obviously should be avoided; the unanimous agreement by those concerned with environmental education about its possible incorporation into a single discipline seems significant on this point. Recourse to active methods, to flexibility allowing for very unfettered thinking, should nevertheless not be allowed to lead a disorderly mushrooming of ideas and to unfinished -- not to say neglected -- projects. This is why clarifications, syntheses, partial presentation of results and, in general, all the methods for keeping the environmental problem being studied in sharp focus should be regularly applied at every stage in the process. This implies sound preliminary expression of the goals of environmental education and the pedagogical objectives attainable within the project framework.

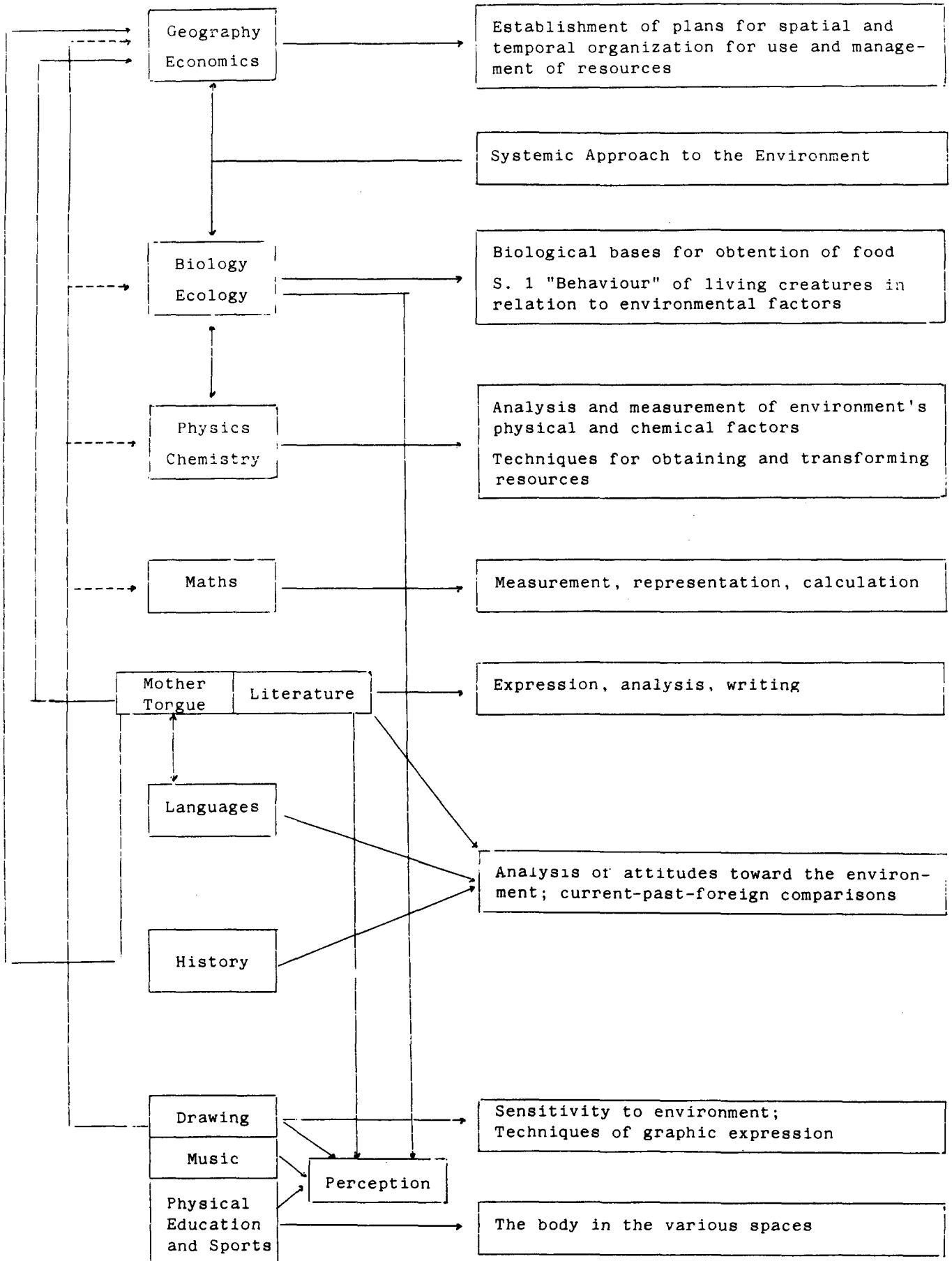
It seems, in fact, extremely important that environmental education activity not appear in competition with disciplines that more often than not maintain their independent development, but as complementary and enriching. If it is admitted that the problems raised in environmental education arise precisely because they affect the lives of teachers and students within their community, then the fundamental nature of environmental education should be recognized; knowledge acquired in the disciplines that is applied to reflection, analysis, expression, then takes on added justification (see diagramme on page 24). Interdisciplinary complementarity in environmental education can also function by having the disciplines call on each other for elucidation of precise points.

Environmental education thus be really integrated into teaching, even when disciplinary structure is very marked. Uncommitted school time should, in any case, be set aside for analysis in the field (observation, investigation, etc.) and concrete action concerning the environment; these periods will not, however, be isolated from the overall school programme, since the results of teaching that is completely open to the outside will in return enrich even that part of the scholastic programme that has remained in form.

Incorporating interdisciplinarity into educational practice is an arduous enterprise that should be achieved gradually. It implies easy contact among educators made possible by a new kind of training and adequate institutional organization of teaching.

DISCIPLINES AND THEIR CONNECTIONS  
WITH A VIEW TO  
INTERDISCIPLINARY TEACHING

TYPES OF CONTRIBUTIONS



PART TWO :

STRATEGIES FOR INCORPORATING AN INTERDISCIPLINARY  
ENVIRONMENTAL DIMENSION INTO EDUCATIONAL PRACTICE

#### Chapter 4 - AN OVERALL STRATEGY

The unity of environmental education is based on the convergence of educational objectives and the coherence of the pedagogical and methodological techniques used.

Interdisciplinary environmental education is not a discipline, a new subject, but a pedagogical modality aiming at efficient teaching. It is neither an objective nor a goal in itself, but a way to enable a learner to situate himself better in his school programme and to assert his needs in a more global and harmonious fashion than is allowed by the sectorial approach of disciplines, while more easily acquiring the attitudes, methods and concepts necessary to control his environment.

The essential idea is to arrive, "thanks to growing interdisciplinarity and preliminary coordination of the disciplines", at a form of concrete teaching aimed at solving environmental problems or, at least, better arming learners to solve them -- in other words, at teaching them to take part in decision-making.

Incorporating such an approach is not a simple process. The possible methods for achieving it are neither mutually exclusive nor necessarily successive. Possible solutions can be combined. They should, however, be adapted to each country's level of formal education.

##### 1. Renovating the various aspects of the educational process

Establishing interdisciplinary environmental education is not easy, because it upsets the parameters on which traditional teaching rests. The first step is to move from linear instruction, in which each notion is taught successively according to a pre-established order to systemic teaching. This leads to introduction, in interaction with customary analytical teaching, of long synthetic periods in which the system's interactions and contradictions are registered and the elements emerging in the analytical phase are discussed and integrated; traditional education expected the learner himself to synthesize the information he acquired, to distill from it a global vision of the reality around him and seize the relationships among its elements.

Moreover, insertion of environmental education objectives and content requires changes in educational systems to renovate them in all their aspects, for current, empirically inspired education is no longer adapted to problems that were born with industrial development and urban growth. It no longer bridges the gap separating official directives from the student bodies for which, in principle, they are intended; besides, the innovations affecting learners lead to new distortions.

Also, mere information is not adequate to carry learners through to this question of the environment recommended in the final stages of environmental education, for the problem is to transform approaches, attitudes, human behaviour. Such a conception has a strong impact on education.

Evolution of the educational situation must be gradual, because of the difficulties inherent in so vast a conceptual and institutional transformation. Foundations must be laid now that will permit reinforcement



of environmental awareness and of an environmental ethic on a world scale. The machinery must also be constructed that will foster development of the scientific and technical capacities needed to meet the problems of improving our frame for living. And it must stimulate popular participation in the process of conception, decision and control of new development policies. There is no hope of finding viable solutions to problems of the human environment without altering general and specialized education at all levels. The purpose: to enable people of all ages and origins to understand the fundamental relationships uniting them to their environment and to foster behaviour that will contribute to a continuing improvement of that environment.

This change should bear on the determining elements in the system: the conception of programmes and educational strategies. But for its realization to be fruitful, it must take account of a number of facilitative elements: teaching aids (books, school material, audiovisual equipment), the school environment (organization of school time, the architecture). Similarly, there is no chance for such innovations to take hold unless the personnel involved have both the spirit and the skills necessary for applying them: teacher training is the limiting factor that must be insisted on. However, the development of environmental education implies not only training teachers, but also training the personnel assigned to direction, inspection and planning, who, for many reasons, often limit innovation.

## 2. Possible strategies of incorporation

### 2.1 Restructuring disciplinary content (Solution 1)

In this connection, a first phase could bear on the revision and restructuration of the contents of all the disciplines. This is the easiest phase to realize, because it is controlled by national or regional directives.

Educational programmes can be conceived in other ways, first, by introducing an environmental dimension into each of the traditionally taught disciplines; second, by not establishing a separate programme for each discipline, but by taking steps to help teachers of the various subjects to better coordinate their activities; third, by proposing programmes that are not based on a succession of subjects to be studied imperatively, and suggesting a series of possible supports with a view to realizing a body of coherent objectives.

#### Introducing an environmental dimension

Since part of the disciplinary objectives must be covered in an imperative manner, and since lengthening or multiplying disciplinary instruction on any given level is to be ruled out as materially and temporally impossible, programme conception should be eased so as to introduce this initiatory dimension into the problems of today's world as they are viewed in the traditional subjects.

Much of current programmes could be eliminated in favor of a new orientation. In the natural and social sciences, this still applies chiefly to lessons in concrete nomenclature. In the best of cases, the object studied is recognized by direct observation and its details

object studied is recognized by direct observation and its details inventoried and linguistically defined from direct observation -- this is exceptional -- or after examination of a diagramme. For observation of an insect or a river, descriptions are usually supplied by the teacher along with the required new vocabulary; lack of time or the cumbersome-ness of the programme frustrates efforts to stimulate a need for further explanation.

Many subjects are redundant: the systemic study of related animals, of similar geographical structures. These facts are still being taught because of tradition, even though their actual usefulness to most learners is no longer very clear. But, out of habit, teachers hesitate to discard them.

The teaching of reading and writing of the mother tongue is heavily stressed in mandatory schooling, yet most of the time is taken up by strictly mechanical exercises using nineteenth-century writings that describe for instance, farm labor that was still manual, even though mechanization is spreading today. Besides, most learners nowadays live in cities. Using current writings bearing on the learners' real concerns would involve them more closely and would create a need to understand the work; understanding here serves as both a pretext and a support for learning.

In the advanced classes, explaining a written passage almost becomes mere parsing from which nothing is learned. Information is plastered over spontaneous understanding with no attempt made at motivating the acquisition of this new knowledge by an accompanying comprehension. This explains the learner's annoyance at an exercise which he sees as pointless. Here, too, reading could satisfy a need to understand or to know, that is, it could respond to a curiosity, a surprise most often in the student's lived environment (surroundings, mass media).

Similarly, in mathematics, despite an undeniable effort to reduce formalism, teaching remains abstract, cut off from reality. Yet preliminary concepts would profit from being built on situations in the learner's environment and from being reinvested to test the extent of their validity and effectiveness on that environment.

Generally speaking, the tendency today is to avoid presenting students with complex problems such as might arise from their surroundings. Yet what splendid motivation is to be found in an encounter with the reality of a necessary, even if imperfectly known, operation! These are indispensable exercises, yet they are rarely employed in classic pedagogy.

Confining ourselves to essential sectors and concepts, the following tables bring out the points on which reorientation of programmes might bear while maintaining present disciplinary boundaries.

### Coordination of disciplinary activities

A programme common to all the disciplines must be elaborated. This programme should be established through collaboration of all those in charge of the disciplines. But it cannot be worked out by teachers alone because these problems are too complex for a simple pedagogical approach. Teachers should be joined by experts in the disciplines, experts in disciplines not yet being taught, architects, economists, planners, researchers in educational sciences as well as administrators, decision-makers, officers of environmental-protection groups.

Such a programme is an indispensable element in avoiding the incoherence of the separately conceived programmes now in operation, and it is vital in going beyond the disciplinary framework, especially if a programme is established independently of pressure groups made up of those supporting standard disciplinary teaching. There are three sources of this pressure: inspectors, university professors and associations of teachers of the disciplines.

There is another element that is important to consider in conceiving a programme, and that is the need to help teachers to coordinate their activities. Simple solutions are possible here: giving teachers not a dry list of points to deal with, but a more ample description including ideas showing the bridges between disciplines, indicating how a concept can be picked up in another discipline (for example, the concept of system developed in geography can be carried over into technology), suggesting the use of material from one discipline in another (for example, construction of an ecosystem can be used as a drill in mathematics; conception of an urban development plan is also usable in learning linguistic techniques, etc.).

Nevertheless, the essential is to conceive programmes based not on a succession of subjects, but offering a series of possible supports so as to realize a body of coherent objectives. Environmental education as it was defined at the Tbilisi Conference cannot be given in the form of "lessons" in tightly pre-programmed succession and continuity. Especially when a teacher wants to help learners solve problems arising from their lived environment, he cannot follow a linear programme. Learning a method, building a concept and, especially, changing attitudes cannot be achieved directly by pre-determined exercises. Information must be gradually organized in a structure through exercises in comparison, generalization, reinvestment of data in other areas so as to reach a precise definition of their extent and meaning. The concept of a food chain is not immediately apparent from looking at and describing a pool, but through comparison of a number of cases to be explored in both ecology and geography. The teacher must also include other concepts in his structure -- matter, energy -- that may have been constructed in physics.

A table of interdisciplinary objectives is, therefore, essential. It determines the directions, the processes gradually attained in school through the disciplines. Thus, by keeping to the spirit of a table of possible objectives, a teacher, even when continuing to work in the strict context of his discipline, can refine his students' methods so as to achieve coherent, because interdisciplinary, educational goals. A rough outline of such an interdisciplinary table has been developed in Chapter 3 of the Unesco Teacher's Guide for Environmental Education. It suggests four main

Natural Sciences

Areas	Concepts				
<p>ECOLOGY</p>	<p><u>Living creatures</u>                      - relationships of individuals within a species                      - rapports between species and environment</p> <p><u>Ecosystems</u></p> <table border="1" data-bbox="598 663 1362 819"> <thead> <tr> <th data-bbox="603 663 979 757">Structure</th> <th data-bbox="979 663 1358 757">Function</th> </tr> </thead> <tbody> <tr> <td data-bbox="603 757 979 819"></td> <td data-bbox="979 757 1358 819"></td> </tr> </tbody> </table>	Structure	Function		
Structure	Function				
<p>ETHOLOGY</p>	<p>Behaviour</p>				
<p>HYGIENE</p>	<p><u>Environment-connected diseases</u>                      - Origins                      - Means of combatting them</p>				
<p>DEMOGRAPHY</p>	<p>Population</p>				

Physical and technological sciences

Areas	Concepts
<p>MECHANICS</p>	<ul style="list-style-type: none"> <li>- Space</li> <li>- Time</li> <li>- System</li> <li>- Interactions</li> </ul>
<p>CHEMISTRY</p>	<ul style="list-style-type: none"> <li>- Material resources</li> <li>- material cycle (conversion, renewal, exhaustion)</li> </ul>
<p>TECHNOLOGY</p>	<ul style="list-style-type: none"> <li>- New energy sources</li> <li>- Studies of existing technological systems :                             <ul style="list-style-type: none"> <li>- distribution systems: water, gas, electricity</li> <li>- communications and data processing (learning construction techniques)</li> </ul> </li> </ul>

Social Sciences

Areas	Concepts
ECONOMY	<ul style="list-style-type: none"> <li>- Production</li> <li>- Consumption</li> <li>- Distribution</li> <li>- Development</li> </ul>
SOCIOLOGY PSYCHOLOGY ANTHROPOLOGY ETHNOLOGY	) Coordination of elements, relationships, ) groups in History ) Comparisons, causes, consequences
POLITICAL SCIENCES	Search for organizational and institutional principles : <ul style="list-style-type: none"> <li>- Who decides? Who carries it out? In what framework?</li> <li>- According to what priorities? What options?</li> <li>- According to what values?</li> <li>- Meaning and contribution of change?</li> </ul>

Mathematics

Areas	Concepts
ALL AREAS GROUPED	<ul style="list-style-type: none"> <li>- Building concepts based on situations in the learner's environment example:               <ul style="list-style-type: none"> <li>. group</li> <li>. univocal and biunivocal</li> <li>. relationships, etc.</li> <li>. identification</li> <li>. Cartesian product</li> </ul> </li> <li>- Approximate calculation, evaluation Dimensional calculation</li> <li>- Reinvesting concepts in solving concrete environmental problems</li> <li>- Combinative structures: separations, combinations (interactions) of factors</li> </ul>
STATISTICS	<ul style="list-style-type: none"> <li>- Construction, analysis and interpretation of facts, tables</li> <li>- Significant differences</li> </ul>

Indigenous languages

Areas	Concepts
Reading Writing Literary appreciation Technique of expression and communication	- Building learning on: * current writing or free expresison of environmental reality * analysis of speeches, writing, advertising, television programmes, newspapers * use of indigneous languages in discussion of work, communication of solutions, actions (with exercises)

Visual arts

Areas	Concepts
ARCHITECTURE & URBANISM	Use and development of space, forms, colours (association with functions, possible life styles)
TECHNIQUE OF EXPRESSION	Analysis and confection of signs, means of representation

Physical Education and Sports

Areas	Concepts
UTILIZATION OF SPACE AND OF THE BODY	Favour perception of the space and inter-relationships between the body and the space

groups of objectives: acquisition of attitudes, methods, essential concepts, and clarification of values objectivizable by a group of indicators.

The disciplines can then join in tackling the construction of a concept. For example, the concept of space and its development can be worked out in the sciences (with physics), in the visual arts (with problem of structuring space), in physical education (with perception and utilization of space). The concept of energy can be constructed with specific contributions from physics and the social sciences (economics, sociology), supported by language training so as to analyze the energy needs of societies through their literature and publications. The disciplines can also work together to bring out the interactions among areas. Should a marsh be drained so that the land can be farmed? The answer depends on:

- ecology: comparative protein production of the marsh and of cultivated land;
- economics: need for and value of various products, influence on on coastal fishing;
- sociology: state of the labour market (1), etc.

The table of objectives should be so conceived as to emphasize the objectives of environmental education and their translation into indicators that teachers can identify in order to base their work on attainment of these objectives. It should, of course, be constructed from discussion among the disciplines, but it should not be subject to disciplinary negotiation or compromise, because the aims of interdisciplinary environmental education have first priority. It should be worked out at the same time as the programme, even before it, if possible, since the programme is only an instrument for the achievement of these objectives.

## 2.2 Disciplinary convergence (Solution 2)

The goal of this second approach is to begin to crack the disciplinary yoke. It results from the convergence of subjects having some affinities of concept, method or area. Its first stage might consist of efforts to clarify an integrated system of teaching the sciences, grouping biology, physics, chemistry, geology and technology in an environmental approach. Similar attempts can be made to combine the social sciences -- geography (2), psychology, sociology, economics and political sciences -- toward the same end.

In the second stage, combinations can be made of disciplines that could be called conceptual, because they supply the basic concept of an environmental approach (3), with instrumental disciplines serving as supports

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- (1) More and more areas overlap. Institutional restraints block the steady development of new areas and the creation of new fields of investigation like those taught in the universities: eco-development, socio-politics, physical-chemical ecology, etc.
  - (2) Geography is fortunate in already being a semi-integrated discipline using the methods and concepts of such other disciplines as economics, urbanism, pedology, etc.
  - (3) We do not mean to say that mathematics is not a discipline that deals with concepts, but it is less fruitful for the environment, being useful essentially as an operational support.

of expression (language, both indigeneous and foreign) and operation and logic (mathematics).

The possible combinations are grouped in the following Cartesian table:

"Instrumental" disciplines / "Conceptual" disciplines	Indigenous Language	Foreign Language	Mathematics
Natural Sciences	*	*	*
Physical Sciences	*	*	*
Technology	*	*	*
Social Sciences	*	*	*
Visual Arts	*	*	*
Physical Education	*	*	*

But the conceptual disciplines can in turn play instrumental roles for other conceptual disciplines. Physical education, for example, can play a basic part in young learners' perception of space (a concept usually constructed in physics). The visual arts can serve the social sciences (economy) as a means of reading advertising and television images. Technology is an essential support for the construction of materials involving soft (non-polluting) energies as well as mock-ups that aid in understanding space development.

Inversely, conceptual disciplines can serve as supports for understanding instrumental disciplines, which then play a conceptual role. For example, ecology can help in analysing a newspaper article about oil pollution; physics can help in understanding a science-fiction novel about the evolution of cities, etc.

From this point, other groupings are possible between practically all the disciplines, taken in pairs. This brings us to the third stage. It consists of blending three or four disciplines among which cognitive and methodological networks can be established for the study of a given problem. If the study is to be about waste, it can be undertaken in the combined sciences: physics (recycling materials), biology (hygiene and microbiology) and, in the social sciences, with economics (labour costs, profits from recycling), sociology (labour and its problems), etc. Repopulation of a forest zone devastated by fire can be studied through the sciences (problems of cultivation in biology, the soil sciences in geology), in the social



sciences (cost problems in economics) and in the visual arts (development of the future forest area).

### 2.3 Teaching through interdisciplinary projects (Solution 3)

Finally, the most complex, but possibly the most satisfying, stage in attaining the ends of environmental education consists in breaking down the compartmentalization among traditional disciplines and integrating the contents of the various subjects in study programmes in a framework of interdisciplinary environmental "projects".

This pedagogy by projects functions as an integrative unity consisting, as in the preceding solution, of a group of objectives to pursue and a study of a subject or problem crucial to the environment. There will be no arbitrary, a-priori distribution of tasks among the disciplines, however.

After a period of maturation in which the problem is approached globally, disciplinary methodologies are used, for the most part, with a view to, successively, analysing the situation, organizing it into problems, finding alternative solutions, proposing desirable and appropriate actions. Of course, analytical phases occur throughout the process, but they are constantly made relevant by reference to the other disciplines in a process of systemic analysis. Through the use of the fundamental concepts, instruments of logic and operational criteria of the specialized disciplines these analytical phases allow students to gather a maximum of information about the reality surrounding them and its dynamic. But this does not mean they give a full understanding of the environment, for this is global in the multiplicity of its dimensions. The environmental system is not simply the sum of the factors constituting an ecosystem; it exists through their interaction. Hence an integrated system is structured that is qualitatively different from its component elements and that cannot be reduced to them without destroying it (1).

What are the characteristics of such an interdisciplinary approach? They follow from the meeting on a given subject of different disciplines seeking to study the same phenomenon through different and complementary approaches. But, this multidisciplinary convergence is desirable only if the teachers have previously defined a body of common objectives toward which the disciplines will converge.

Among practical modalities for such a disciplinary convergence, two phases are essential. There is, first, the common period when the teachers on the team compare their viewpoints so as to clarify the problem to be studied, decide on the objective to be envisaged in the work and allot tasks in a complementary way. Second is the terminal phase, when the disciplinary contributions are combined to synthesize results and decide whether to end the investigation. It would be preferable, however, that this concertation be maintained throughout the project so as to keep teachers constantly abreast of questions, to rectify the allocation of tasks and to profit from unexpected discoveries and points that were not foreseen by the team.

It is important to understand that an interdisciplinary methodology of research and education cannot be constituted in advance, for this is a dynamic process crowning an investigation. It is a reorganization of specialized information, so much so that it changes their concepts and

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(1) MORONI, A., "Interdisciplinarity and environmental education", in Prospects, Vol. 4, Unesco, 1978.

boundaries, regrouping them in a new and original form by bringing out both the unity and diversity of phenomena and thus helping to solve often complex and difficult environmental problems.

In this light, then, disciplinary phases should alternate with integrative phases. During the disciplinary phases, subjects should no longer exist in terms of their own development, but, in serving an interdisciplinary project, should function as study instruments. Integrative phases, on the other hand, should provide specific and original data not supplied by classic teaching. They enable researchers to establish and evaluate the interdependencies and relationships that emerge by registering the dimensions, the characteristic processes that give a particular system (a social group, an ecosystem, a space) its own way of functioning, its own history.

It is true that the approaches are combined, but the disciplines should not, therefore, lose the particularities that give each its value. Each subject should maintain its approach, but a team spirit should reign to coordinate the work. This spirit should not shut out contradictions on the pretext of team conviviality; on the contrary, contradictions should be fully explored. What is most important is permanent unity in the team toward attaining the objectives laid down for environmental education.

Formulation of an integrated educational approach to environmental problems requires an overall elaboration of forms.

Horizontal integration of study projects should first be established, and this implies, for example, setting aside non-disciplinary periods presided over by teachers acting as discussion leaders and researchers rather than as instructors in the particular disciplines. It is more important to reappraise the principle of fragmentation as a prerequisite to analysis adopted by the disciplines for the study of any complex problem than merely to establish "diplomatic" (compromise) and "trade-off" (swaps) relations among the disciplines in which each confirms its sovereignty. Teachers should instead make a point of reflecting about interference, interrelationships, interaction, opposition and complementarity among the participants. "Articulated disciplines open to complex phenomena and, of course, an ad hoc methodology are necessary... A theory is also needed - a transdisciplinary idea." (1) In addition, since disciplinary phases can no longer be preprogrammed, they should be composed to order in terms of the study's requirements. Although there are times when a discipline is excluded, there are others when it can function as the team's captain. A vertical integration should be envisaged to assure a coherent progression of environmental education and provide a link to extracurricular activities for such an approach cannot be conceived in an insular framework.

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(1) MORIN, E. Le paradigme perdu: la nature humaine, Seuil, Paris, 1973

Chapter 5 - SPECIFIC CHARACTERISTICS AT THE SECONDARY LEVEL

Secondary education today is characterized by a time schedule strictly arranged in disciplinary sections, in each of which a specialized teacher usually officiates. A strict programme and, sometimes, a body of objectives are required for each school year.

Establishing a system of environmental education in secondary schools is now possible in many countries as a result of a large number of educational experiments, either in the form of coherent, organized projects or of attempts at flexible scheduling (10 % - school clubs, workshops, classes outside the school, etc.). To envisage introducing environmental education into a school system means specifying a number of innovations in programmes and methodology. Over a period of time, it can lead to redefinition of disciplinary teaching.

Programmes should introduce an environmental dimension while increasing flexibility so as to foster interdisciplinarity. It is enough to earmark a place in each sector for the elements best suited to participate in environmental education or for a group of directives promoting environmental education activities, or both.

As far as school time is concerned, the teacher divides it - the proportions vary with the levels at which he works - among the disciplines, devoting part of his time to the discipline's theoretical and formal aspects and part mainly to carrying out environmental education activities and preparing guidance he may feel is needed or that appears necessary from the questions asked. Finally, he should have time enough to take a concrete part in field activities and in the indispensable interdisciplinary work of coordination with his colleagues.

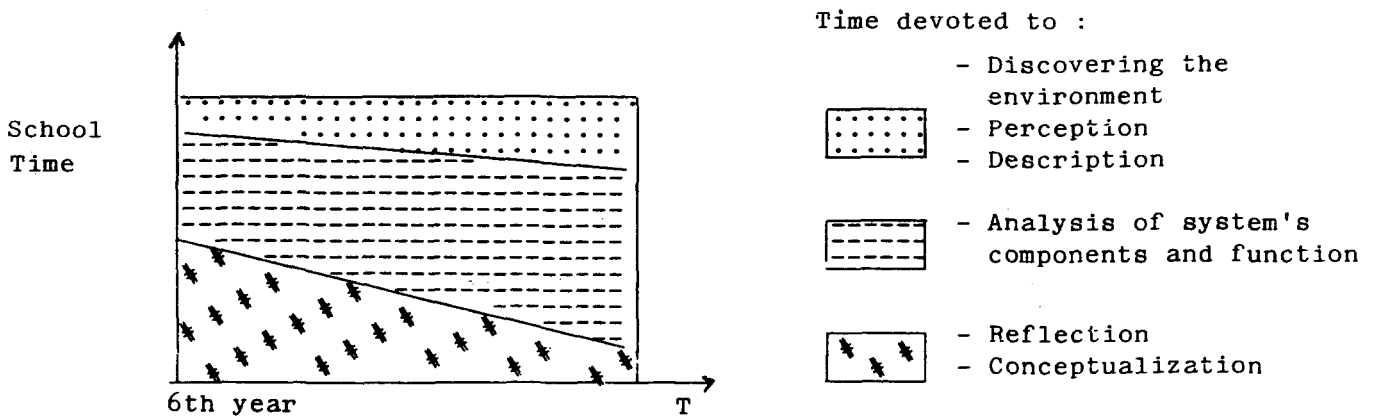


Fig. 1

Pupils will thus find time devoted to environmental education both in class in the disciplines and during specific environmental education periods (field activities, reports of analysis, expression of results, etc.).

A few general principles can serve as guides in the choice of programmes, pedagogical methods and activities. In the earlier grades, discovery of the environment, even mere perception, will occupy much of the time; systemic analysis of functions will taken on increasing importance in the higher grades; It is only in the highest that the theoretical aspects of environmental problems (analysis of management, the role of economic systems, philosophic views on ideological and value systems, etc.) and more abstract methods of thinking about certain concepts can be considered (see fig. 1).

The teachers together form an educational team, but it would be illusory to suppose that this team can always be present at all environmental education activities. It is more realistic to envisage a team built around, say, two teachers (who have been trained in disciplines already essentially oriented toward environmental education, whatever their specialities), who would be present in all periods assigned specifically to environmental education. Sessions of coordination and synthesis by the teachers or by teachers and learners together would complete the arrangements and ensure interdisciplinarity. It is extremely important that, at the start of the year, the team quickly bring out the themes and directions for study and make valid estimates of the chances for success. Still more broadly based meetings can be organized to create an opening toward the community.

In any case, interdisciplinarity is not to be reduced to a choice of theme (systematic practice of this procedure could become artificial). There is really a wide diversity of types of interdisciplinary approaches. The central point of the undertaking is that teachers have time to concert their efforts.

Under the research of a disciplinary convergency (Solution 2), the teaching team (1) meets before launching into an approach to the problem of the environment to try to discuss with the students the objectives sought in the study and to parcel out the various assignments.

This coordination should be pursued throughout the project to settle on details of the link between subject content, technical methodology, etc.; it also enables teachers to ask their colleagues for information, a complement, a technique they had not known was needed. It should go until the end of the study and, if possible, until action is taken to promote the envisaged solutions to the specific environmental problem in hand. This final phase is specially delicate and requires a maximum of preparation by the teaching team.

Such a coordinative procedure is relatively easy to establish because it does not require preliminary agreement by large numbers of teachers, which is not always readily obtained. It enables each teacher to complete and enrich his knowledge with material from other disciplines; it also improves understanding of the difficulties of learners beleaguered by the often exaggerated demands of each discipline. A teacher of a single discipline judges as an expert, and always underestimates the difficulties of his subject.

Interdisciplinary approaches in environmental education can be

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(1) In getting underway, it is not useful for all the disciplines to be represented; common problems are then too difficult to manage for teachers unaccustomed to this kind of coordination.

facilitated by teacher pluridisciplinarity, that is, study by a teacher that overflows into other disciplines; A certain polyvalence on each teacher's part is implied in this concept, or at least solid training in allied subjects (biology and mathematics for a physicist) or in any others teachers might choose (a geographer who is competent in architecture or a music-loving mathematician). This challenges sacrosanct hyperspecialization, but it should not mean that teachers have no specialities. On the contrary, added rank should be considered for teachers having the concepts and basic instruments of several disciplines and who are capable of making disciplinary interrelationships.

Another possibility is offered by a pilot discipline (the teacher as orchestra conductor). The motivation and classification phase is begun in one discipline, where the concertation phase also takes place, with the other disciplines coming in on request to give part of their time and methodology to dealing with problems raised in the pilot discipline (see diagramme). The study is then conducted within a single discipline, but it is supported by the others. This allows both the teacher and the learners to call at any time on the teacher of another discipline to supply a needed methodology or technique or to satisfy students' curiosity on a particular point.

A third possibility is offered by coanimation: two or more teachers working with the same class. This can be managed successively: work on a subject is begun in one discipline and continued in another, etc. Each teacher functions both as a stimulus to move the study along and as a specialist to reply to the learners' specific questions. This can also be done by two teachers working simultaneously with the same class. The presence of two adults, each trained in a different but complementary discipline, is very profitable to a class. It especially breaks with the old relationship of a more or less univocal teacher ("he who knows") and an "ignorant" student; it fosters an exchange of viewpoints, brings out the nuances or divergences between approaches and thus diversifies the students' grasp of problems. One of the teachers can be replaced if the study requires it by outside experts who contribute special skills: technicians, architects, physicians, administrators, etc.

These regroupings require changes in scheduling. Various methods have already been tried:

- Common responsibility: periods are marked out in which two or more teachers take a class together.
- Partial standardization of schedule: A block of time (15 %) is chopped out of the regular schedule. This provides either one day a week or ten days a trimester in which groups of learners and teachers can work unhampered by the usual restraints. A period is freed for solving a problem in a context of environmental education. During that time, other students and teachers can be engaged in parallel activities.
- Workshop structure: Habitual disciplines can be taught for part of the time, in the morning, with the afternoon free for clubs or workshops devoted to a specific study. Each workshop is chosen by the students and directed by one or more teachers. Since the workshops are non-disciplinary, teachers are less tempted to impose their traditional methods.
- Course structure: A group of students and teachers work for a given period (from a week to a month) on a specific activity. The structure is mostly used now to study a different environment: excursion classes, nature classes, sea or mountain classes, etc. The accent should be placed, however, on

coordinated work by teachers that is not limited to class excursions. A mixed system can be applied to these periods, with morning spent in study of classic disciplines and afternoons devoted to extracurricular studies (in the usual sense of the term), the environment being one area that can easily be taken up.

Specific courses can be given on approaches to environmental problems provided they are not limited, as so often happens, to protected environments -- national parks, and so on. These courses can also be given in situ to explore the problems arising in the learners' immediate environment, especially urbanized and industrialized areas.

- Modular structure: The school can be organized, not in classes, but in modules of 40 to 100 students led by teams of six to eight teachers. The teams organize functional interdisciplinary activities, discuss how to apply the different disciplines and how to use the joint periods for the pursuit of common objectives, and assign duties.

Schedules may be set up progressively when the learner-teacher group is not too large. More formal structures are also possible in which a day or a half-day per week is devoted to activities that are sometimes undertaken together, sometimes separately; periods of exploring the environment, structuration periods (analysis can be made within the disciplinary framework), transmission of data to groups of students (by outside experts, if necessary), periods of concertation by the teachers or by teachers and learners together, even tutoring of faltering students.

Only the initial phases -- organization and clarification of the problem -- the intermediate phases of structuration and the final phases of proposals, action and evaluation require the simultaneous attendance of all the learners and teachers of all the modules. Investigation in the field or in class can be made by small groups with or without a teacher; teachers can make the rounds of the groups as their specialities require. There are times, if material conditions allow, when students can very well work alone; teachers, meanwhile, can develop their concertation or work with students who have fallen behind. Similarly, while a large group of students is watching a film or listening to a lecture by an outside expert or a teacher, the others are freed for interdisciplinary activities.

Such a system breaks down habit, the stultifying everyday routine of one class, one teacher, one classroom, a fixed time. Just as data can very well be transmitted to large groups of students, especially with the aid of audio-visual equipment, so students can sometimes work on their own. On the other hand, constructing a concept is a very individualized task that can only be done by a small group helped by several teachers at a time. This type of methodology frees time for devotion to more delicate pedagogical work.

The third solution (pedagogy by projects), in which the point of anchorage is not the disciplines, but the realization of a project for solving an environmental problem, naturally requires complete decompartmentalization.

Scheduling cannot be too rigid; it should allow time to reach the heart of a problem, should take account of learners' motivations and methodological needs, facilitate an interrelations-interactions approach and foster structuration. Activities should be allotted as the project development requires. This means that school structures must be altered to free periods long enough to enable students to work together and teachers to guide their methods and activities.

Workshop, course and modular structures are better suited to this kind of pedagogy; teachers act throughout the project to furnish learners with the means of understanding the problem or the structure. But architecture that provides for such activities, as well as suitable educational equipment and interdisciplinary teacher training, are equally necessary.

## Chapter 6 - SPECIFIC CHARACTERISTICS AT THE PRIMARY LEVEL

Environmental education must be instilled in children when they are very young; a late start means an arduous effort to break through already formed habits and attitudes, the stereotypes and images the learner has absorbed from his daily life with the help of the mass media.

Interdisciplinary environmental education, therefore, must begin in primary school. Despite appearances, it is more difficult to realize because the teacher, usually the only teacher in the school, must function as an expert in all the disciplines. It can, however, find support in fairly flexible programming that usually has as its objective "awakening the child" while teaching him reading, writing and arithmetic. Interdisciplinary environmental education really situates itself in the task of alerting children to the world around them. In many school systems, substantial periods are set aside for this, sometimes a third of the standard schedule. This period is essential to the inception of interdisciplinary activity. A point we consider basic must be stressed, however: the teacher, even if he is alone, must function in an interdisciplinary way instead, as so often happens, of operating as a specialist in each classic discipline; this presents learners with a compartmentalized structure: "we're having biology... or geography... or drawing" as a succession of subjects.

Teachers should change their methods, then, so as to guide their pupils' activities by keying the disciplines to the resolution of environmental problems, thus anticipating the interdisciplinary phases devoted to the ripening and synthesis of a problem.

The three solutions recommended for secondary education can also be applied here: introduction of an environmental dimension, disciplinary convergence and pedagogy by projects. Setting aside time for heightening learners' consciousness provides ample opportunity to introduce pedagogy by projects, since scheduling constraints, especially, are fewer.

A single teacher can introduce a disciplinary technique immediately, or he can carry his teaching through a structuration phase, as the work dictates. The class then functions in a workshop or modular structure as defined above (see page 35). Several classes can be combined with their teachers in a system of open classes: each group can then work, not with its usual teacher, but with another who, by choice or because of his specialization, has the instruments needed to answer learners' questions about the point under study.

The use of outside experts can be very fruitful here; since a single teacher cannot be skilled in every subject, the help of an expert bringing an approach, tools, techniques or concepts usually stimulates learners' interest while enabling them to acquire new methods. The outside expert should nevertheless make a pedagogic effort to put himself on the level of learners who do not have an adult's, much less an expert's, frame of reference and logical instrumentation. The teacher must therefore keep tabs on the outsider's work; being familiar with the learners' project, with the obstacles encountered, he should help the outsider prepare his work in class and should join in it to orient it toward the learners' real needs. He should function on the same level as the expert, with the latter contributing the fruit of his skills while the teacher relates these to the educational project at hand.



The course structure is also well-adapted to primary school teaching. It is used chiefly to take learners out of their customary surroundings and encourage encounters -- as well as exchanges of data -- between learners and teachers. While maintaining these objectives, this context is particularly conducive to the introduction of interdisciplinary environmental education.

Interdisciplinary environmental education is also a notably valuable support in teaching reading, writing and arithmetic. Through the variety of subjects it encompasses, the environment is a source of motivations prompting learners to read books and newspapers. When they have finished their work, they feel proud of being able to present the results as a dossier or an exposition or as letters to the appropriate authorities, all activities that can serve as bases for exercises in writing, spelling, style, communication. Such exercises have the advantage of not being mechanical, but the result of a normal and potentially useful process. Similarly, the environment can spur the study of arithmetic; creating sets, establishing relationships and combinations, counting, identification, etc. It thus roots the learning of how to reason in a less abstract context and avoids the many difficulties created by overly formal exercises providing little motivation.

One sector too often forgotten in environmental education today: nursery school and kindergarten. Yet this is the most fertile terrain. Because there is no disciplinary programme, it allows for teaching that is very open to learning mechanisms and the formation of children's attitudes:

- (1) Time can be devoted to the child's immediate environment: his classroom, his school, his house and perhaps later his neighbourhood, or the development of a space that concerns him ;
- (2) Periods of sensitization can also be used to study such problems as nutrition (artificial colouring in sweets), noise, etc.
- (3) Emphasis should be placed on perception of space (especially of the child's body in space). Forming a pro-environmental attitude can be achieved through small environmental gestures: planting trees, picking up paper, arranging a play area. This involves such parameters as a critical spirit, communication, self-confidence, curiosity, sociability, interest in the child's surroundings, coincides with development of his personality, which is the goal of pre-school education.

THIRD PART :

OBJECTIVES OF RESEARCH IN THE FIELD OF  
INTERDISCIPLINARY ENVIRONMENTAL EDUCATION

Chapter 7 - PROBLEMS RAISED BY INTERDISCIPLINARY APPROACHES IN EDUCATION

Interdisciplinarity is one of the important research hypotheses in promoting environmental education, but it is not particularly original; interdisciplinary teaching is an objective of general education in many countries. It introduces a factor of change in daily pedagogy by sensitizing teachers to the need to reappraise their work and their habits. It especially stimulates them to clarify their educational objectives, to center their work on the learner. It also improves relations among teachers, among learners, between teachers and learners through the sessions on concertation, the machinery of common projects and pursuit of the same general objectives.

We should not, however, let ourselves be fooled. In the present state of pedagogical knowledge, interdisciplinarity has been shown to have negative aspects: loss of know-how and of specialized knowledge. Everywhere it is tried it runs up against habit, a bureaucratic mentality, gaps in teachers' training. Many difficulties have come to light during teachers' concertation meetings and in efforts at temporal and spatial organization of school activities. To this are added gaps in documentation, which is usually too specialized and is hard to find. Moreover, this pedagogical method, when poorly assimilated, can sow confusion in learners' minds. These problems seem comparable in all countries in which these strategies have been adopted.

There still has not been enough thinking, enough experimentation, that is, well-grounded, systematic research, to remedy these defects. Research should bear on teaching methods (educational strategies and pedagogic equipment), organization (proper scheduling, balanced planning, school architecture) and, of course, on training teachers. For interdisciplinarity can create an uncomfortable pedagogical situation for a teacher: he is no longer a teacher of ----- and so he loses some of the support the knowledge of a discipline provides, finding himself instead hesitant and lacking adequate preparation with which to confront complex problems whose solutions are not always evident.

On the other hand, interdisciplinarity environmental education interjected between real life and the school gives profound coherence to schoolwork; it creates a link to life in the school by associating children, adolescents and adults in a single center of reflection, implying for all of them a rethinking of convictions and behaviour. But this takes time, the will to reexamine pedagogic habits and at least a minimum of means, without which interdisciplinary environmental education is impossible.

## Chapter 8 - ORIENTATIONS IN PEDAGOGICAL RESEARCH

### 1. Content and educational objectives

One area in environmental education research that demands a special effort is reform of content and educational objectives. A new programme is required in order to incorporate at all levels an interdisciplinary environmental education oriented toward solution or prevention of concrete environmental problems.

These programmes should not be centered on a list of themes; their purpose is to incite teachers to implant the objectives of environmental education in learners' minds. It is on this point, particularly, that thinking should bear, and mainly on conceptual objectives. While educators are beginning to understand clearly the objectives of the attitudes and methods to be instilled in learners, master of the necessary conceptual tools is slight.

### 2. Pedagogical methods

Environmental education must adopt, as we have seen, a holistic outlook covering the ecological, social, cultural and other aspects of each question. It must begin, however, by dealing with problems the students know well because they encounter them at home, in their community, their country, and it must aid them to acquire the knowledge, skills and sense of values needed to help triumph over these difficulties. This means, as we should again remind ourselves, that environmental education not only supplies information; it also teaches how to read the lessons of that information, which in many cases necessitates revision of some well-established pedagogical methods.

A course can no longer consist of lectures alone, nor can it even take a Socratic form (1). Types of activity should be alternated, investigative phases, phases of structuration, reinvestment plans. In the investigative periods, learners are led to clarify the problematic situation, identify and seek data with which to tackle the problem from different approaches: inquiry, observation in the field, sometimes experimentation, documentation.

Recourse is had to the same phases for devising solutions and plans of action. Structuration phases will alternate with these investigative phases in which learners are led to compare and pool the information they have obtained, their solutions to the problems and their plans for action with a view to arriving at a more exhaustive analysis, a proposal for action or a later evaluation of their work.

The nature of the teachers' action, then, varies with the vicissitudes of the educational project and the obstacles the learners encounter as they go along. At first, teachers are present mainly to encourage detachment from the situation, communication among the learners and the search for information. At other times they act as mediators, suggesting other sources of data, contributing new concepts or new disciplinary or interdisciplinary instruments. After many phases in which these methods alternate, the work would end with a synthetic phase in which the teacher or team encourages the learners to make a decision or an evaluation or to broaden their approach to the problems under study.

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(1) Usually in the form of a teacher-learner dialogue in which the teacher's very indirect questioning will elicit from the students what he would have said in a lecture.

The initial theme is broadened and deepened in the course of the work; sometimes it is even shifted to follow the group's spirals of thought. Thus, gradually, an area of research is defined and new questions crop up from this. Teachers must maintain an attitude of permanent pragmatism; this can be made easier by an analysis of teaching practices. But since this is still not being done, areas of research are yet to be defined.

### 2.1 Knowledge of learning mechanisms

At present, there is a wide gap between the way teachers teach and the way learners learn by a wholly different system of logical construction based on data teachers do not expect. It is necessary to know more about the learners' learning mechanisms. These are still little understood in the classic disciplines and totally ignored when it comes to interdisciplinary work. Approaching them may even be easier in an interdisciplinary context because few the basic mechanisms of knowledge are built through a discipline.

Research into this problem should be undertaken, especially into the adaptation of scientific methods of investigating problems and the construction of some fundamental environmental concepts, particularly by the identification of indicators showing how learners perceive and control the environment. These researches would also open on to a number of useful instruments giving teachers a better understanding of learners' frames of reference, their way of reasoning, of integrating information and reinvesting it in approaching new problems, etc.

### 2.2 Evaluation of teaching strategies

If progress is to be made in this field, it is increasingly necessary that what is really happening in the classrooms be analyzed instead of limiting ourselves to a vague idea of what teachers and teaching teams want to do or think they are doing. Teachers too often simply adopt innovations for innovation's sake without trying to evaluate what is really being done or what it is bringing learners.

Here, too, useful research should bear on both observation in the classroom and on the results of teaching strategies already adopted. This could finally lead to an inventory of teaching situations or actions to propose, or, on the contrary, discourage the conceptual assimilation and development of an attitude that is only vaguely environmentalist. More particularly, analysis of precise classroom situations would provide better understanding of teacher-learner interaction and the interrelationships among disciplines.

Final evaluation of the pedagogical project would provide an indication of how enriching it is to learners and of its impact on the environment. This would point to adjustments and changes in the teaching hypotheses for other operations (cumulative analysis).

Formative evaluation should also be developed throughout the education process by bringing out what is acquired by the learners, and the blockages encountered during the learning process.

Such research should also bear on evaluation of objectives and on how much rigor can be tolerated in an educational stage. Objectives cannot be reached through a single approach, as classic pedagogy maintains, but must be gradually constructed and continually reinvested if they are to take root. Although behavioural objectives should be stressed for young learners, most objectives should be dealt with together and early on. The next step is to determine the level that can reasonably be reached; such a level of exigency cannot be predetermined; it should be defined in terms of students' learning. It is interesting to see if a methodology or behaviour in one discipline has been transferred to another. This is one of the most pertinent indicators of this kind of education: the scale of reinvestment. It shows whether what is learned has any chance of being transferred into an approach to real environmental problems.

It is also desirable that research aim more systematically at evaluating this teaching's contribution to learners.

## Chapter 9 - RESEARCH ORIENTATIONS CONCERNING HUMAN AND MATERIAL RESOURCES

Environmental education can be reached to some extent without major institutional changes in the framework of a simple restructuration of contents of disciplines (Solution 1). Any institutional innovation in this area, however, greatly facilitates teaching teams' work, especially as regards weekly or annual planning, school architecture and teaching aids (documentation, audiovisual equipment, etc.).

The key characteristic in designing such changes should be sufficient structural flexibility to satisfy interdisciplinary needs that vary with times and situations.

### 1. Planning and architecture

The interdisciplinary strategies proposed recommend a number of temporal changes. Decentralizing the disciplines requires that a number of teachers work together with the same class at the same time. Some solutions already exist: structure, workshop, interdisciplinary period, modular structure arranged by teachers and learners together. There is, then, no uniform mode of conduct in this area, so it would be preferable that each school system experiment to find the structure that best suits its own conception of interdisciplinary environmental education.

School scheduling often depends on school architecture. A shortage of classrooms is also a limiting factor. Classrooms have always been designed to hold a particular number of learners, 30 to 50. Interdisciplinary environmental education is thus limited in two directions. Lack of large spaces sometimes makes it difficult to arrange an exhibition or debate to sensitize other learners to the problem under study. Lack of flexible arrangement of space is an obstacle to splitting up work groups and doing specific jobs (experimentation, photo laboratory, map study) (1). To this is often added a lack of space for documentation or film projection or even just a place in which to keep samples or build and leave a mock-up.

Schools can no longer be conceived as rows of identical classrooms; different kinds of spaces, preferably transformable, are needed. Studies should be made of the problem with the participation of architects and administrators. Shouldn't schools be the first environments to develop so as to satisfy educational needs?

Along with the regular schools, reception spaces should be planned (centers of initiation in the environment) that would, for example, provide approaches to another milieu in the form of special courses. Unfortunately, such spaces are too often conceived as mere shelters. Prospective studies are needed to plan for places where learners can really think about their projects; this would lead to analyses in the field and in the laboratory (with the help of specific teachers or experts, arrangement of appropriate spaces and materials). It would

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(1) Specialized rooms (science, geography, music) exist in some schools now, but they are only open to learners for classes. It is difficult, for example, to project a film in the science hall without disturbing other students, or to consult documentation during a geography class.

also be useful to implant such spaces in non-favoured areas (cities, suburbs, industrial parks, depopulated zones, etc.), which correspond to local environments where most pupils live.

## 2. Teaching aids

In most countries, these consist of disciplinary teaching aids (documents, audiovisual material, learning modules) and of raw technical materials (zoning plan, volumes, volumes of laws and decrees, official journals, etc.) not conceived from an educational point of view.

These technical elements are very dispersed, not always easy for teachers or students to find or use. Interdisciplinary documentation centres would improve educational efforts by collecting, handling and disseminating elements pertaining to the environment.

The work of preparing teaching materials should be done on several levels, first, by diversifying aids (aids to sensitization, data supports, technical aids) and, second, by balancing them to provide for the two stages of an environmental approach, disciplinary and interdisciplinary. Also desirable are aids (books, films) devoted to the principal environmental concepts (energy, matter, urbanism, area development) in the analysis of structure, function and interrelations with other problems. Many aids should be localized in such a way as to deal with problems of the learners' immediate environment.

Finally, basic research should bear on the very conception of teaching aids. Too often they are inappropriate to learners' age, vocabulary, thought system and motivations. It is true that we still know very little about how learners read images, interpret commentary, draw information from the perpetual flood of data in which they are immersed.

## 3. Training and retraining of teachers

Interdisciplinary environmental education requires facilitating structures: schedules, buildings, materials and administrative willingness to use these methods. But environmental education cannot function heuristically unless something is done about training and retraining of teachers. This is probably the decisive point, and the most difficult to realize.

Interdisciplinary work requires that teachers seek common methods, sections, languages and objectives. It therefore requires training or retraining that prepares them to use new methods. But a functional link is also necessary between daily practice and pedagogical evaluation so as to refine and specify these methods in terms of fundamental objectives and of the student body. Another kind of general pedagogical training thus seems necessary, training that will prepare teachers to elaborate simple methods and instruments of research and evaluation by which they can test the effectiveness of various elements of the educational process (programmes, methods, structures and teaching equipment) in terms of the interdisciplinary objectives sought.

This converges with a general need for teacher training that does not apply to environmental education alone. Given the complexity of education, teachers can no longer be mere instruments carrying out directives. They must be the driving force of a changing dynamic, for it is they who are best placed to judge and modulate educational practice.



But here again, we must not let ourselves be deceived. This reform will not happen spontaneously; teachers need to be trained and then supported in their practices and the innovations they bring to their analysis of educational problems as well as in their search for possible solutions. This could be the task of a professor of methodology, stimulating pedagogical reflection and supplying - or encouraging the common elaboration of - instruments for analyzing pedagogical situations and resources, elements serving teachers not as directions to follow, but as instruments for the self-regulation of their teaching.

Where training is already pluridisciplinary, means must be provided to make it interdisciplinary. The simplest approach to start with seems precisely that of studying concrete cases of environmental problems (on a theme of environmental improvements in a given framework). Teacher training curricula should include units or modules that enable teachers and student teachers working with such subjects to :

- (i) apply the information and know-how acquired in the disciplines;
- (ii) proceed to a systemic approach that will show the need for interdisciplinarity;
- (iii) acquire the techniques of analyzing the environment, expressing the result, formulating proposals for concrete action and establishing ways to implement that action;
- (iv) specify the aims of education in general and relate the goals of environmental education to them.

Teacher trainees should join in the search for teaching methods carried forward in a spirit created by teachers' awareness of environmental education's educational role in preparing people to live as individuals and, especially, in society.

If training is monodisciplinary, or oriented toward a limited sector, careful reflection is indispensable. This should take place before or during the procedures suggested above and should be based on critical analysis of the following points :

- (i) the discipline's role in society, bringing out the relationship to society of those who construct the elements studied in the discipline (researchers, creators, etc., and those who use the knowledge they supply;
- (ii) the discipline's part in an interdisciplinary approach to environmental problems, stressing the real meaning of that part rather than its mere technical contribution (example: in problems of administration of goods and resources, mathematics serve as a support to economic calculations, but what does it mean? What are their limits as an aid to discussion?);
- (iii) the teacher's role, not only as an expert in his discipline, but as an educator and a citizen living in society.

On a practical level, teacher trainees should also be urged to seek out the elements of their discipline that can contribute to environmental education in such different areas as reflection, analysis and expression, and conversely, to identify the aspects of environmental problems that can be applied in their disciplines.

As in the above-mentioned case, action with environmental education will remain the essential element in training these teachers. This presupposes that the training team is large and varied enough to illustrate by itself the notion of

interdisciplinarity. It would certainly be very profitable as well to envisage interdisciplinarity among teachers trainees and to include them in teams of working teachers (as part of their on-the-job training, for example).

### 3.1 Pre-service training

A number of experiments have been made throughout the world on the early stages of teacher training. Here, too, gradual change has been noted since an environmental dimension was introduced into existing disciplines, generally in the natural and social sciences, including the creation of reflection groups focused specifically on environmental education; this is paralleled by a search for a balance between training in a discipline initiation into educational sciences and the learning of classroom practice by a student-teaching in the schools.

The following training scheme has proved effective; an interdisciplinary group of teachers takes charge of a group of trainees and centers their attention on environmental problem. After a global exploration of the situation that familiarizes them with the terrain and with outsiders who are concerned with or expert in the situation, the teacher-trainee-educator team defines a number of problems, the solutions to which require additional scientific training and comparison of disciplinary methodologies.

Along with their interdisciplinary training, the trainees approach some of the general techniques they lack -producing audiovisual material, for example. They will also be initiated into methods of observing learners and analyzing educational situations from a recording of a class at work on a given question.

In a second phase, the same problems will be tackled in classes assigned to the student-teachers. Ongoing analysis of pedagogical situations by the other trainees - who take the class in turns - and by the trainees' professors of psychology and of their particular disciplines bring to light the specific teaching problems that arise, especially difficulties in learning.

When both phases are complete, the work group can try to find solutions to the educational situations revealed and can deal with practical problems: arranging reference libraries, producing teaching aids.

In some cases, study of an environment can begin with the study of another. The shock caused by the change of setting, the distanciation it affords, makes access to and understanding of the problems easier for the trainee. These practical phases are not enough, however; they do produce awareness, especially of interrelations, and an introduction to methodology, but they do not exempt the student-teacher from effective study of the environment in which they live.

### 3.2 In-service training

The best system of ongoing training seems to be short refresher courses alternating with regular teaching. The courses should satisfy explicit training needs of the teachers, who plan an important role in organizing the courses, determining their objectives and evaluating their results. They should cater for teachers who have practical experience, but who need a new dimension: sensitization to interdisciplinary environmental education and the working instruments that will enable them to make their own changes in their teaching methods.

What is essential is effective articulation of individual practice with analysis and comparison in an effort to deal with teaching problems in their totality, rather than from a disciplinary angle. At the same time, teachers taking the course should explore an environment with a view to reinvesting their thinking and arousing a spirit of research.

Many difficulties remain concerning teacher training; the systems already developed have revealed epistemological, methodological and psychological lacunes.

On the epistemological level, trainees' teachers still too often think of training as disciplinary; the same obstacles arise as are found in efforts to promote interdisciplinary activities among young learners. The same kind of research is needed here.

On the methodological level, interdisciplinary activities are balked by certain phases that are necessary for environmental education, but inhabitual in a school context. The most worrisome aspect stems from one of the chief aims of this type of education: acquiring the ability to make decisions. At the end of the educational process, an individual should be able to act, that is, not only to make to make decisions toward solutions of current problems, but, to a certain extent, to foresee problems that can be expected to arise in the future. Teaching practice in this respect is still largely ineffective.

On a psychological level, two aspects are still largely ignored in choosing teaching methods. First, the problems connected with genetic psychology, especially the learning process, require closer study. Pedagogical methods can no longer be made empirically or at random; they must be based on the mechanisms that govern the acquisition of knowledge. Second, problems arise from lack of mastery of certain elements of social psychology: relations among individuals. These are particularly acute in interdisciplinary environmental education, in which teamwork is desirable -teams of parameters in such relationships are unknown. If we wish to see this approach developed, studies are also necessary. Of course, progress in social psychology and sociology will also help greatly, but specific research should be done. Work in school, the confrontation of adults with students, combinations of specialists all produce specific components.

4. The function of pedagogical research in the development of interdisciplinary environmental education

It is through reinforcement of its scientific base that each society acquires the endogenic capacities it needs to conceive and elaborate environmental programmes and methodologies and that equip it to better evaluate and adapt foreign experience in this sector.

Socially effective development of interdisciplinary environmental education implies the elaboration of national policies and strategies fostering research in environmental education on which to base needed institutional and pedagogical changes. Organizations concerned with environmental education should be given the institutional means to do research that will illuminate environmental policy decisions to avoid their being empirical and institutional when they should, of course, be based on a rational and scientific analysis of educational problems.

Aside from epistemological research aimed at better defining the structure of environmental problems, such research should be of the research-action,

type, with essentially practical ends: providing teachers with the proper training and instruments of evaluation, perfecting interdisciplinary teaching aids, designing structures that will foster the development of interdisciplinary environmental education.

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