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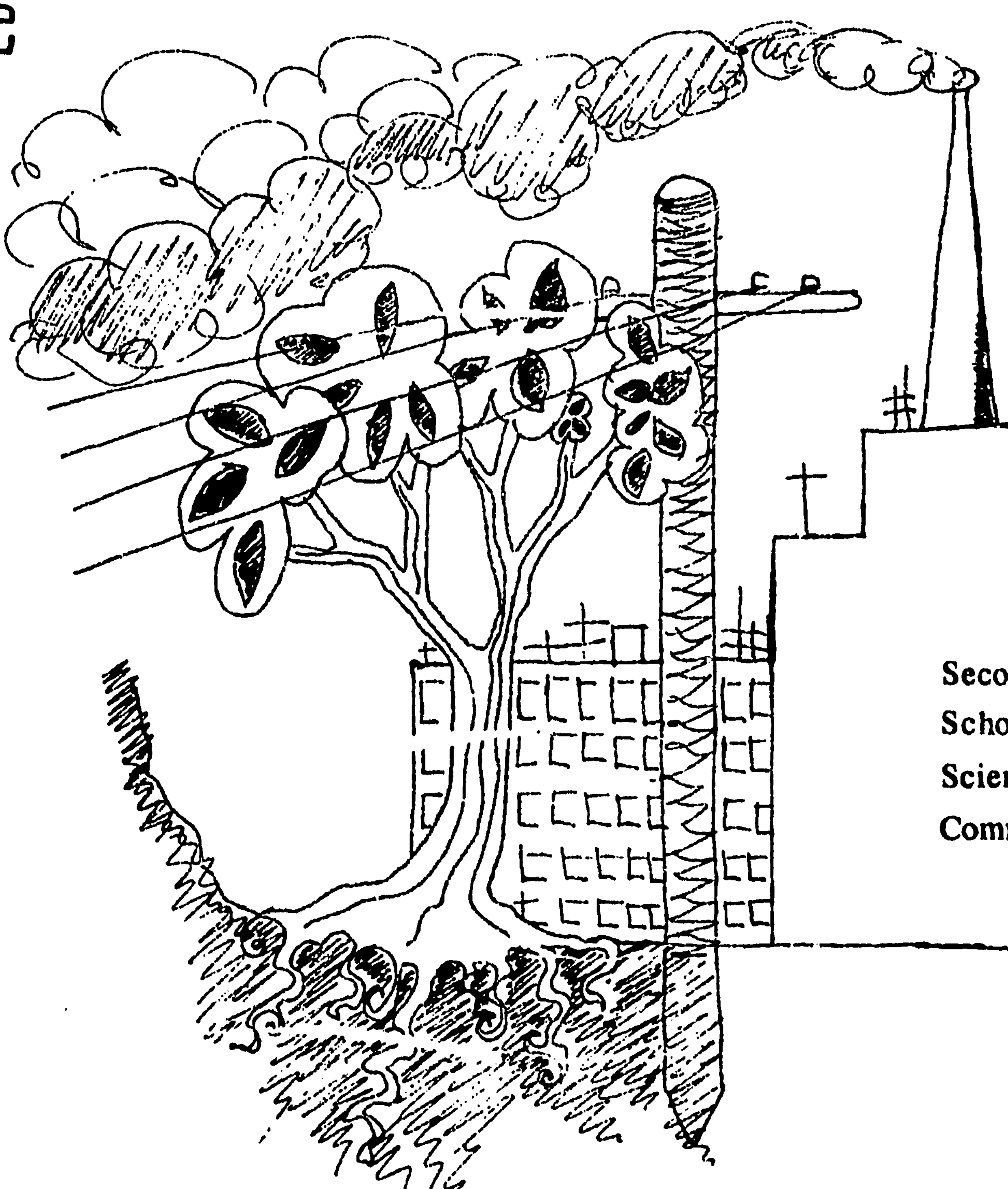
ABSTRACT

In addition to complete texts or summaries of a number of papers considering the scope and relevance of "environmental studies" to the secondary and elementary school programs in Victoria (Australia), many teaching techniques are described. Techniques for measuring carrying capacity of roadways, examining published air pollution data, estimation of smoke haze, collecting meteorological data, and tests of observation skills are outlined. A bibliography of books and journal articles, particularly of those useful in Australian schools; a list of films and other audio-visual aids; names and addresses of organizations and government departments interested in conservation and community involvement; and outlines of possible curricula are also included. (AL)

ED 065274

Conference Report

February '71



Secondary
Schools
Science
Committee

ENVIRONMENTAL STUDIES

AC.71/339 (C. & R.)

SECONDARY SCIENCE COMMITTEE CURRICULUM AND RESEARCH BRANCH

ENVIRONMENTAL STUDIES and SCIENCE TEACHING

- CONFERENCE: FEBRUARY 1971

The contents of this circular are the proceedings of a conference on Environmental Studies and Science Teaching which took place at the Secondary Teachers' College in late February, 1971.

The conference was organized and run by members of the Secondary Science Committee in conjunction with the Curriculum and Research Branch of the Education Department. Participants in the conference were mainly co-ordinators of Science in High Schools throughout the State.

Many people made valuable contributions to this conference, and the members of the Secondary Science Committee would like to extend their thanks and appreciation to these people.

The Secondary Science Committee would also like to thank the Secondary Teachers' College for the use of its facilities, without which the conference could not have taken place.

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SECTION I. THE LECTURES.

The conference programme contained three lectures on educational aspects of Environmental Studies.

The first lecture, delivered by Dr. G.A. Ramsey, Assistant Director of the Australian Science Education Project, was the introductory lecture of the programme. In it Dr. Ramsey discussed the meaning of the term "Environmental Studies" and outlined an approach to classification of the components of the environment which assists in the education of consequences for science teaching.

The following is Dr. Ramsey's paper, reproduced in its entirety because of the number of requests to do so from participants in the seminar.

ENVIRONMENTAL STUDIES - WHAT IS IT?

It is an 'in' word, isn't it? Start a few [illegible]
"environment"

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ENVIRONMENTAL STUDIES - WHAT IS IT?

It is an 'in' word, isn't it? Start a free response session with the word "environment", and very soon words like pollution, litter, smog, high-rise flats, balance of nature, ecology, squandering of resources, natural heritage, come tripping out.

A quick scan of the daily press mirrors our concern for our environment. As an example, I quote some headlines from "The Australian" of Tuesday, 23 February, 1971.

Firstly, Robert Lehane's article headed "Finding more ways to make megawatts" begins with the statement:

"The world's first electric power-station was built in New York 88 years ago. If the present rate of construction continues, the entire land surface of the U.S. would be covered with power plants in less than 200 years."

On the adjacent page part 2 of the Ian Moffett series "What is our Wildlife Worth?" starts with a comment of a grazier's wife - "Kangaroos? They have no right to be here. This is sheep country ..." and ends with the statement "Where is the right place for the kangaroo - inside a can of pet food?"

In the same paper, there was a supplement on Oil and Gas. One advertisement in this section, placed by B H P Oil and Gas Division, and Mematite Petroleum Pty. Ltd. begins -

"Since the installation of the five B H P and Esso off-shore platforms, marine and bird life has flourished. In fact, there's something of a mini population explosion going on in Bass Strait" ...

Some other headlines in the same supplement included
"A weapon in the fight for clean air. Getting rid of the haze".
"Bigger share of the Energy Market"
"The oil companies - a concern for the control of pollution".

To some people, a study of the environment would mean taking up some of these issues or studying examples of pollution - in rivers, in the sea or in the air. It would mean fighting for the preservation of the kangaroo, for the introduction of electric cars or the provision of more parks. It would mean being 'for' this and 'against' that. But surely such actions or activism should result from environmental study, and not from the basis for such a study. We must study the environment in the widest sense of the term with an open mind and without prejudice, if we are to avoid the bandwagon approach which has us attempting to teach the latest tit-bit on pollution to a benumbed and bemused class. Before we can make value judgements about the environment we must have a sound knowledge of it, with the various elements placed in some coherent system for the students. For this reason I believe the scientific processes and attitudes are central to any environmental studies. Many of these processes and attitudes are well-known to you and I will simply list a few as reminders:

Observing and ordering observations
determining patterns and relationships
formulating problems
demanding evidence in support of claims
seek rational explanations
represent observations honestly

This does not mean that the skills of the artist, poet, or novelist do not help us in our appreciation of out environment. They do. Science cannot help us appreciate the beauty of a sunset, but it can tell is that the sunset is red because of the smog in the air.

Man has always studied his environment, and has tried to impose some order upon the myriad of seemingly disconnected events and happenings in it. Some societies and cultures try to impose order using a sophisticated system of myths as, for example, do our aboriginal people. Our advertising would lead us to believe that we have our own system of myths for describing our environment, and when a rational daily paper spends a large section on "Yours Stars" it certainly supports the contention. Even so, we are science teachers and we would agree that our society in its rational moments, would choose to impose an order based upon science and its methods. Science must form the core of a study of the environment if we are to find workable solutions to the myriad of our environmental problems, and if we are to make full use of our resources without prejudicing future generations.

To provide a structure, which may provide some order, and to raise some points for discussion, I will focus out thinking on three main areas:

1. Broad content themes
2. Student understanding of the environment
3. The role of institutions in an environmental studies program.

Broad content themes

I presume we have in this room teachers with differing educational backgrounds, teaching children with differing aptitudes, attitudes and the rest, in schools of differing philosophies and resources, in neighbourhoods of differing social and natural background. We could add to this set of variables, teachers in other countries teaching in other languages, in environments very different from our own.

Yet, if environmental study is to mean anything, there must be common threads in all of this. What are the common threads which pull together the enormously complex set of systems we see interacting ever differently in the total range of perceptual experiences which go to make our contact with a given environment?

I don't think it matters much whether we think of Pierre in Paris, Hank in New York, Wally in Warrnambool, John in New Guinea, or Mary in London, there are dominating themes which organize events in the society in which they find themselves.

To illustrate what I mean, let us look at the forces acting in the environment which brought us all together in one place at one time this morning - more or less! I shall illustrate using my own case as an example, but you could substitute your own, or that of Pierre, Hank, Mary, John, Wally or anyone else in any society. The broad themes will come out much the same.

The alarm went off - a non-verbal signal, or a communication event heralding the start of the day. It may be cock-crow in another society.
The clock was read - 7 a.m.; a knowledge of time is required. Again, a less Westernized society may use the height of the sun in the sky.
I must leave at 8.15 a.m. if I am to arrive on time; acceptance of natural order, past experience a guide to future.
I read the paper; watch the weather forecast on TV; instant communication.
I shower; warm water, energy source.
I cook the toast; provision of energy in a wire.
I eat the toast; energy source for the day's activity.
I bring the milk; energy source, transport, communication.
I dress; shall I wear my pink shirt and flower-studded tie? No, it might create the wrong impression!
Communication.
I say "good-bye". "Don't forget to bring home ..."
Communication, natural order.
I shall go by car. I need petrol, an energy source.
I am confident I can get it from the gas station; communication, natural order. "Eight gallons please" - a knowledge of quantity and measurement impose order. I turn the key. It starts. I am confident that the natural phenomena engineered by man to serve his locomotion will not have collapsed overnight. Even if it hadn't started, I would not have blamed the gods or kicked its tyres to make it go. I would assume some perfectly natural explanation -

1. Broad content themes

2. Student understanding of the environment

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insufficient electrical energy source (dead battery)
no chemical energy source (no petrol)
or unsatisfactory matching of chemical and electrical (no spark)

I drive to the city. Speed varies between 0 and 40 miles per hour - and the distance is nine miles. I assume the order imposed by measurement, time and speed.

The trip is only possible because of the order imposed by a set of rules, and by the varying kinds of communication, some verbal, much non-verbal which marks the way. The flare of a stop-light, the flash of a turn signal are examples of the constant barrage of communication, all requiring an energy source, and all ensuring some kind of order in the traffic flow.

> On the way in I pass by a continuing panorama of man modifying a natural environment which has been observed and described. Its very predictability through the "laws of nature" have meant that we have become a little too smart - the West Gate Bridge, Californian earthquakes and Orbost floods give us occasional reminders. None the less, it is the very order we can impose so readily on our environment based on the scientific knowledge we have gained about the environment that has led us into trouble.

It does not matter what sequence of events you describe for yourself, nor in what culture, five major themes organize the events. Activities like getting to a certain place on time, whether it be to this meeting, or a landing on the moon, have five threads as unifying themes.

They are -

communication
measurement
energy
time
natural order.

All cultures, all environments work within these five. Exemplars for each of the five will change from culture to culture and school to school, but they can provide unifying themes on which environmental study may be based. And with this as a framework, some of the environmental problems confronting society may become more meaningful.

Communication

So much of our environment and what goes on in it may be summarized under this heading. The world abounds with signals of all kinds, and students should be aware that so much of what we do is organized by the various ways we have of communicating. We have language and verbal signals. We have non-verbal signals, all imposing a control and order on what we do. Communication is not only giving information. We can extend out study of communication in the environment to art, music and the general area of aesthetics.

Of course, communication can degenerate into noise. The competing neon signs, blaring of radio and transistor, are all examples of noise pollution, or examples of degenerated attempts at communication. To understand noise and all the pollution that word summarizes, one must first understand communication.

When students can understand signals man - man, man - animal, animal - animal, he can start to see some of the factors which prevent the signal coming through. Thus, the core of an environmental study must be to explore communication using scientific processes, and then expand out into the attitudinal areas of what constitutes a lack of communication or noise, or into other forms of communication where the message is much less clear, as in poetry, music, art.

We, as adults, are well aware that many of our environmental problems are magnified by poor communication, and that effective communication between people or groups depends so often on how closely the value systems of the two groups are parallel. If students were led to an understanding of what communication is, then the role of effective communication in problem solving or conflict reduction would at least be appreciated.

Measurement

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Measurement

The interpretation and accurate description of our environment relies on measurement. Each society has struggled with its own form and we still have many counter systems, as my daughter found out recently, when she had to learn things like -

$16\frac{1}{2}$ feet = $5\frac{1}{2}$ yards = 1 rod, pole or perch

6080 yards = 1 nautical mile

7.92 inches = 1 link

16 ozs. = 1 lb.

14 lbs. = 1 stone

16 drams = 1 oz.

Measurement (cont.)

without metric measure receiving any mention, little athletics notwithstanding! Different measures for different things, and so our hotch-potch evolved, costing millions to straighten out.

We have our systems of primary units, and the units derived from them. We prefer to quantify whenever comparisons are to be made, and so standards are of prime importance. We also have counting and calculation involved in measurement, and hence mathematics.

The students can see that measurement and calculation can contribute to obtaining relevant data which creates order in a system. They can also understand the confusion which results when measurements are taken using different systems, or different bases for comparison are used.

They can be led to understand by measuring, the tricks of presentation to make things look bigger than they are, or look to contain more than they do. They could decide which is the better buy when confronted with an array of detergent choices such as -

A costs 56 cents for 4 fluid ozs.

B.costs 72 cents for 6 fluid ozs.

C costs 48 cents for 3 fluid ozs.

D costs 1.68 for 12 fluid ozs.

and E costs 84 cents for 7 fluid ozs.

They might also be able to decide that it is not simply cost per fluid ounce which determines the best buy.

Accurate and reproducible measurements are essential to ensure order in our environment. Students can be encouraged to prefer quantification - data to back up claims. The BHP - Esso ad I read earlier, which stated that the wild life in Bass Strait had increased since drilling operations began would be treated with the question "What is the evidence for this?"

Time

You may see the concept of time as being a subset of measurement. We certainly measure it, and use it to obtain derived units like velocity and acceleration. Yet it seems to have a dimension of its own in our twentieth century society. Time is the great irreversible phenomenon. To the best of our knowledge it is unidirectional. We have grand scale geological time measured in thousands of millions of years. We have phenomena which take place and can be measured in time intervals of thousand millionths of seconds. Time is infinitely divisible, and may be measured precisely. Its passage may be observed by change, and our notions of change and of time are very closely related.

We have the infinity of space defined in time units of light years. We have cyclic processes in nature depending on the rotation of the earth on its axis and round the sun.

Man has taken the temporal organization of the natural environment, with its seasons, day and night, and animal migration and applied it to societal organization. So much that 9.15 a.m. is a command and demand to be present. The world and our society must "run like clockwork" if it is to run at all. Nowhere was this tendency more clearly shown than in the trip to the moon, where exact and split second timing were crucial in all aspects of the flight.

We have check lists, activity sequences, timetables for trains, buses, planes. The school day is divided into eight periods of forty minutes. All these time divisions are again attempts to impose order on our environment. Yet we have conflicting temporal ordering. We have two appointments at the same time. The passage of time to person A from culture X seems quite different to that for person B from culture Y, So we can explore time as a fundamental concept in the natural sciences, and as an important determiner of societal behaviour.

Energy

Our society, the natural world, in fact our whole environment is an intricate web of energy changes and transformations. The earth is sometomes described as a space-ship, with the only input being energy from the sun. To maintain equilibrium in living systems, for example, our constant body temperature of $37^{o}C$, requires constant energy input.

We have intricate systems for transporting energy. We have gasoline, electricity, gas as major mobile sources. We are constantly on the search for new sources of energy, and ways of collecting, storing, and transforming energy. We have solar cells, Wanckel engines, nuclear reactors, and the rest. We are becoming insatiable in our energy demands in this century. For example, the United States with six percent of the world's population uses 50% of the world's natural resources - and the fantastic energy demand this requires.

The students can study energy and its transformations in a scientific way, and also in a social way. Our society is becoming increasingly dynamic and this will require ever increasing energy input. An understanding of the underlying importance of energy transformations to both the natural and social environment will help students understand some of the conflicts which arise as we attempt to maintain the supply of energy at the present rate.

Natural order

Science is one way of interpreting the universe. It does this by applying order to the many disconnected events and phenomena that occur. This search for order is basic to the nature of man, although the scientific method of applying order, with its tremendous power to predict accurately is a relatively recent phenomenon in the history of man. Yet it has been the dominant force in shaping the nature of our social environment. How do we establish a natural order? We observe, classify, hypothesize, and develop a system which first describes a natural order. We classify units of matter, chemically starting with the notion of element, or in terms of fundamental particles. We establish order among living things using the concept of species, and we have hierarchies and chains.

We can describe many of the events of the world in terms of systems - with the components of the system all influencing each other. Most systems have controls and feedback loops which regulate the system. Any study of the environment must use the powerful concept of a system to help order the events of the environment.

So much of what goes on in the environment is part of a "natural order". The study of geology pre-supposes that the present is a clue to the past. That the processes occuring now on the surface of the earth have always gone on.

If it were not for a natural order and its natural outcome, predictability, then technology in its widest sense - man's modification of his total environment - is impossible. The opposite to a scientifically determined natural order is chaos and mythology.

Of course it is not only the natural world on which we attempt to impose order. We can classify, describe and predict in our social systems. Some students may wish to explore the natural environment, others the social.

I have not, to this point, defined the word "environment". I thought, first, that by identifying some of the components, the word may have meaning before I specify it too closely. We tend to use the word "environment" when we want to be loose or vague to describe any source of stimuli which impinges on our perceptive apparatus.

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What should be the aim of a set of learning experiences designed to explore the environment?

We should provide experiences which help the child to develop intellectually, to grow in his understanding of his environment, and to increase his ability to cope with any new environment as an autonomous, self-directed individual.

The word "environment" is used in its broadest sense. It includes the internal (biological, psychological) as well as the external (physical, technological, social, etc.) The criteria for selection of any aspect of this total environment for particular study should centre on its immediacy and relevance to the child's stage of development.

This leads me to the second phase that I want to discuss, and turn to the student's understanding of his environment.

Student understanding of his environment

Students should come to realize the far-reaching effects of the continual non-cyclic modification of his environment, both in terms of the consequences of changes made to the environment and in terms of the effects of the changed environment on man and other living organisms.

Before the student can make informed decisions about changes in his environment, he must understand himself; how he functions in, and operates on the environment. There are three broad areas which relate to the way man functions.

Understanding of themselves as individuals

Students should learn to understand how they function as individuals, compared with how other living things function. What is so special about man? In what ways is he similar to other mammals? What are the important systems which regulate his bodily mechanisms, and his behaviour.

Understanding of themselves as members of groups

Students should learn that for much of their time they are functioning as members of various groups. They need to understand how groups operate, and how the behaviour of individual members of a group affect the functioning of a group.

So many of the important decisions in any social environment are made by groups or influenced by the actions of groups. Students in schools can observe how groups function and learn of their inherent strengths and weaknesses. Perhaps most important for environmental study, most of our efforts to change the environment and the system of values upon which our behaviour is based, arise from group interactions rather than from the needs of individuals. It is important for students to understand this, and its application to the various institutions and pressure groups which operate in our society.

Understanding of the extensions of man

Students should learn about man-made devices and procedures which extend the range of their sensory perceptions, and their ability to use their own energy to move and manipulate.

These extensions of man are essential in helping him order and explain his environment, and to gather the data on which decisions should be based.

Through this knowledge gained about himself, the student can begin to make judgements about the uses and abuses of the great technological advances, and how technology affects man and the natural environment. The students must understand the natural environment and the changes that take place in it before they can be fully aware of man's impact on it. And this must be an understanding gained by looking at the environment as a whole, at all the interacting systems, and not through the artificial divisions of the disciplines we have traditionally used.

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Only when a total concept of the environment is developed can the student be sufficiently aware to trust all parts of the natural environment as resources in balance with each other. Indiscriminant exhausting of one resource will have serious effects on others.

The role of outside organizations in an environmental studies program

The final area I wish to open up is that of the role outside organizations can play in an environmental studies program. Schools so often seem to be environmental anachronisms. Instead of being part of the real world, they create an artificial world of their own which is almost completely cut off from all the important organizations affecting our environment.

We still in our schools have teachers and students talking about organizations that influence what happens in the environment. Talking about it at quite a different level from real experience. What are the organizations that work primarily in the theme area I mentioned earlier - which ones are concerned with communications, or the provision energy needs. You can list these as eaily as I can. How do these organizations impose order using measurement or time?

I suspect there are many organizations just waiting to help, provided someone suggests to them how they might. It has to be much more than having members of the organization coming to the school to talk about what the organization does, however. There must be an integration of community and school, in its widest sense.

One organization which has many ideas to contribute is the Australian Conservation Foundation. They are particularly keen on the provision of outdoor areas and parks for the study of natural environment. Yet the sort of park surely depends on what we want to use them for. How do schools want to use parks and other outdoor areas? What specialist persons do they require in the parks, and on what basis? How are park authorities and school authorities to be integrated?

Teachers and school libraries are not the only set of resources available to a teacher. We must be prepared to bring outsiders into our schools on a consultant basis to work with the teachers and students. We must be prepared to allow small groups of students to go out into organizations that exist to spend a considerable time just looking, learning, and absorbing what is going on. The students could then come back to the schools and pool ideas. I believe that parents should take their children to work from time to time, just for them to experience the real world. Considerable education of parents, employers, teachers and students would be needed for this to be effective, but how better may a student study his environment than to see exactly what his father does, particularly of he is given help in what to look for. To support this idea, it may be pointed out, historically, we are one of the rare cultures which separates the education of the young from community activities. In most societies, those we are wont to label "primitive", the education of the young is the responsibility of the whole community. It is not left to the parents and those isolated institutions we call schools. Why is it that, by and large, schools exist only to educate those under 17 years? What has age got to do with a need for education?

Perhaps an environmental studies approach will help us broaden our concept of education to, in effect, involve the whole community. We know schools will always be necessary. Children must gain certain simple skills before being fed out into society, and they need places of refuge where they can be given time to reflect back on their environmental experiences.

The burden of education is becoming intolerable, both in schools and to the tax-payer. More and more money to give us more and more bigger and better examples of what we have now would be a disaster.

The only effective way out is to involve more and more outside organizations, businesses, libraries, museums, factories - any organization in the education process. In the same way that the role of the teacher has changed in recent years from being the source of information, to being a manager of a wide range of resources to help the child learn, so must the role of the school change from being the only place where a child is expected to learn, to being the management centre which directs its students to tap the environmental resources available.

There is no doubt that the whole concept of environmental studies presents suggests to them how they might. It has to be much more than having members of the organization coming to the school to talk about what the organization does, however. There must be an integration of community and school, in its widest sense.

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There is no doubt that the whole concept of environmental studies presents an exciting challenge for teachers and schools. For too long we have taken our environment for granted. In doing so, we have not only jeopardized future generations, but have, in our teachings, ignored the most immediate and dramatic resource we have at our disposal. In environmental studies you will have to find ways to use this resource. Your questions will now be how to use the environment and all its resources to help in the growth and development of students, rather than how to make the text-book abstraction of the world meaningful to them. In other words, you will be guiding them to make their own abstractions of the world, rather than having them accept the abstractions of others.

Acknowledgements

Professor Sol Encel, Professor of Sociology, University of New South Wales, for his original statement of the content themes and his most valuable discussions on an environmental studies program.

The staff of the Australian Science Education Project who helped formulate the ideas presented on the student's understanding of his environment, and who are committed to an environmental approach in the teaching of science.

Mr. Alan Reid, of the Australian Conservation Foundation, for his comments on the role of outside organizations in an environmental studies program.

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There is one project funded in the United States which has the title "Environmental Studies". They distribute a newsletter which may be of interest. The address is -

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BOULDER, COLORADO, 80302.

Gregor A. Ramsey

Following the lecture by Dr. Ramsey, participants divided up into five seminar groups to discuss the idea of Environmental Studies and the place of such an idea in the school curriculum. A number of points were made in each of the groups and were reported by seminar leaders. The following statement has been prepared to encompass all of these points and to eliminate duplications where substantially the same point was made by more than one group.

All Groups agreed that Environmental Studies was a difficult concept to define. In fact some groups expressed doubt that it was a concept rather than an attitude of mind. It was suggested that although Environmental Studies might be an attitude of mind, a concept, or a fusion of these, it was clear that it was concerned with all the factors in the environment and all the interrelationships between these factors. Generally it was agreed that Dr. Ramsey's lecture had put forward a clear case for much greater consideration of the environment in school curricula at the secondary level. All groups were in agreement that without Science the teaching of Environmental Studies could have little currency or credibility in that Science is a necessary tool in the rational interpretation of the environment. Considerable debate arose as to whether children should be expected to assimilate a considerable body of knowledge or whether they should learn to live in their environment, gaining experience of it and feeling for it, free of the present school regime. It was eventually decided that the present school regime did have something to offer in that it was by this method that theoretical knowledge and technological "know-how", necessary in our present society, were most efficiently communicated to children. One participant voiced what seemed to be in the minds of many; that Environmental Studies would be found eventually to be what a fully explored and extended General Studies programme is aiming at.

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An interesting view of the effect of a teacher's background on his approach to Environmental Studies was expressed by one group. They felt that teachers experienced with B.S.C.S. and ASEP type materials were more sympathetic to the approaches of Environmental Studies than those people not experienced with them. This, they thought, was particularly true of people whose backgrounds were in the physical sciences.

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The second lecture in the programme was presented by Mr. G.P. White of the Curriculum and Research Branch. In this lecture Mr. White was concerned with securing the analysis of data as an accepted, integrated part of science teaching, and with showing that Environmental Studies programmes provide for wide exercise of the relevant skills.

A summary of this lecture is reproduced below.

ANALYSIS OF DATA

Generally, describing and interpreting natural phenomena in objective terms is regarded as the business of Science. (It should be remembered, too, that science by its activities has developed its own implicit definition of the word "objective".) A large proportion of the natural phenomena that science is concerned with may be regarded as "the environment" and, for that matter, science is the only discipline (- or discipline cluster, depending on your attitude to the status of science -) which is concerned with this objective description.

To make the Science we teach in secondary schools appropriate to Environmental Studies in its broadest sense we must emphasize those aspects of science which are directly related to describing and interpreting natural phenomena. Both the obtaining and use of data are important in this context. Although this talk is primarily concerned with the use of data, it should be realised that the way in which data is obtained usually dictates the ways in which it may be used.

For the purposes of this discussion data shall be taken as any objective information - usually, but not always reproduceable - which may or may not have been collated with reference to a particular hypotheses (explicit or not). Data may be in one or more of several forms, the commonest forms used in the classroom being verbal, graphical, tabular, diagrammatic and photographic (including motion pictures and television). The data may also be quantitative or non-quantitative - in the list of data mentioned previously graphical and tabular would usually be regarded as quantitative, verbal, diagrammatic and photographic as non-quantitative (but this need not always be so).

Inclusion of the analysis of data as an integral part of our science teaching can be easily justified. The skills and attitudes which may be developed through the opportunities provided by attention to analysis of data can be beneficial to the student in his learning about the environment of which he is part, his every-day life and his understanding of science. Amongst the skills which might be given practice in analysis of data are:

(1) Data manipulation. Conversion of data from raw to refined form and conversion of data from one form to another. This skill has assumed considerable importance in our present age of burgeoning information and growing awareness that individuals exhibit different facilities with different data forms.

(2) Hypothesis formation.

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(2) Hypothesis formation.

(3) Hypothesis testing. This skill is, of course, fundamental in the testing of assertions. (A particularly important skill in the value laden atmosphere of pollution and conservation.)

(4) Skill in judging the validity, reliability and relevance of data to hypotheses. This practice will also develop awareness of measurement, scaling and reporting skills (- which may be developed by practice in data gathering).

(5) Skill in differentiating inferences and value judgements from observations. (Rather useful when dealing with advertising in the media.)

At the same time as intellectual skills are being developed desirable Affective Domain objectives may be sought. Objectives which might be developed through the medium of data analysis are:

(1) Awareness of the need for intellectual honesty. (Particularly related to skill(4)).

(2) Awareness of Scientific method.

(3) Awareness that Science is an activity rather than a set of facts.

(4) Awareness that Science is relevant to everyday life. (Particularly if a catholic choice is made of data to be analysed.)

(5) Development of a questioning, if not enquiring, attitude.

In conclusion, a plea for fair dealing with both Science and Environmental Studies. The concept of Environmental Studies is a good one so long as Science is kept in its rightful place as the main provider of objective descriptions and interpretations of natural phenomena. Without Science in this place Environmental Studies faces the danger of becoming, at best, lopsided, and at worst an emotional activity lacking in opportunity for a balanced intellectual development for students. Science, on the other hand, to be relevant to Environmental Studies, must be seen as a fruitful <u>activity</u>. To do this we, as teachers, must show students how Science works and where it works. It is important then that we lead students into the activities of Science in as many fields as possible.

G.P. White

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The final lecture in the programme was given by Dr. D.M. Calder, Senior Lecturer in Botany in the University of Melbourne. Dr. Calder is particularly concerned with Environmental Studies and the setting up of environment studies centres in Victoria.

A summary of his talk is reproduced below.

ENVIRONMENT STUDIES AS A BASIC FOR SCIENCE EDUCATION

The human environment is a complex of many factors, physical, chemical and biological, and it seems quite appropriate that environment studies in the broadest sense should form the basis of science courses. Such a basis will provide an additional dimension of relevance to both school and university courses. In the last few years I believe the whole philosophy of education has broadened and there is now much more emphasis on students' first hand acquaintance with the environment. Further, the student has come to expect this greater involvement and relevance.

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The situation now is one where the curriculum opportunities for environmental studies have outstripped the resources of teachers and schools to fulfil them. Hence there is a need to develop a system of environment studies centres to cater for the needs of schools, universities and adult education groups. At the present time such a centre is being planned for Aireys Inlet as the first of several in the State.

This centre would be available for a range of courses which might have as their main objective the study of a fairly narrow field, but which would allow for the integration of that study within the broader context of the total environment.

These centres will have a professional and domestic staff and a residential accomodation for up to 40 students. Most courses will be of one week duration. For school parties it is possible that several teachers might combine to share the time and facilities available to avoid too much disruption of school timetables.

To conclude - I believe that centres of the type we have in mind will enable the development of environment oriented courses which will have great relevance to our community in the years ahead. It will take time to study the full potential, but that there is potential is not in doubt.

D.M. Calder

SECTION 2. PRIMARY SCHOOL SCIENCE AND ENVIRONMENTAL STUDIES

During the programme two speakers discussed primary school science and the environmental aspects of these courses.

The first speaker was Mr. R.L. Verso of the Curricul . and Research Branch. Mr. Verso spoke in detail on the Victorian Primary Schools' Science Course, illustrating the environmental bias of this programme. The text of Mr. Verso's paper is reproduced below.

SCIENCE IN THE PRIMARY SCHOOL

Primary school science and secondary school science - are they the same thing? What does science in the school mean to you?

To the general public science may mean a little more than "What I learnt in high school science lessons." Ask any parent what he expects his child to learn in science and listen to the list of evergreen experiments he gives you - kerosene tins buckling under air pressure, limewater turning milky, pretty blue crystals of copper sulphate - are just some of the favourites. As likely as not the parents memories will be of partly seen teacher demonstrations and notes from the chalkboard carefully recorded into notebooks with routine headings and a conclusion which is entered irrespective of the success or failure of the teacher's demonstration. My own most vivid memory of that mysterious subject called science was as a form one student in a metropolitan high school. Filled with awe, bursting with eager anticipation I, together with forty or more of my fellow students, gathered eagerly for the first science lesson. We watched wide-eyed as this highly learned man, this worker of scientific miracles, this science teacher, revealed to us the mysteries of the bunsen burner. He showed us how to light it, how to change the colour of the flame, and expounded on the wonderful process of combustion. Then, being a progressive teacher, he introduced child activity into the lesson. We linked up, each armed with one match, to take our turn at lighting, adjusting, and extinguishing the burner. (What did you say lad? Your match broke? Then get back to your seat and copy the notes. Perhaps you'll learn to be more careful next time.") Of course, most of us had on occasion lit the gas stove at home and made mum a cup of tea, but there can't be any science in that can there?

What of the science teacher? How does he see science? Too often, I fear, his definition can be boiled down to "What I do in my classroom." A teacher with such a narrow concept of science teaching may find difficulty in accepting primary school science, for primary school science is, of necessity, different to secondary school science because, simply, the children are different. They think differently. Children in the primary school do not think like little adults. They are, in Piagetian terms, in the intuitive stages early in their primary school life, and later may be expected to move into the stage of concrete operations. In general, it could be said that the primary school child must operate in concrete situations, whereas the secondary school child is becoming capable of abstract thought. This, of course, does not mean that the child undergoes a sudden change at a given age, or that there are not exceptions to be found in both the primary and secondary school. The important point to be made is that, on the whole, primary school children are not capable of operating in the same manner as may be expected from older children or adults.

D. Pickering (of the Curriculum and Research Branch), writing on the course of cognitive development as seen by Piaget, brings out this difference very well. From the stage of concrete operations,

"The final step taken with the child moving towards complete decentering, perceptual influence is removed and from the myriad concrete experiences the child becomes capable of abstract thought. He can be guided by the form of an argument and ignore the content. He is capable of considering all possibilities inherent in a situation. The child is now capable of calculus, probability and proportionality. His cognitive processes are capable of acting independently of his perceptions and his environment." Pickering adds the following words of comfort for any secondary school teacher who fails to recognize the above as a fair description of many of his students.

"The description is of a child achieving optimum development, and it would come as no news to teachers that all children do not achieve this optimum development."

Primary school science is not secondary school science made easier. It is designed for children at a quite different level of cognitive development. It is designed to be concerned with concrete situations. It is to develop the child's understanding of his environment. The following is an extract from the Primary Science Curriculum Guide.

"Science has an important place in the primary school. Taught in the way advocated in this Guide, Science can assist in the development of a style of thinking which has wide application. It can lay a basis for later work in science, mainly by providing a variety of experiences and developing the pupil's ability to think.

One way of looking at science is to regard it as a series of ideas that explain, or link together, a large number of observations; the ideas suggest further experiments and observations, and so help to extend our knowledge; in the process of investigation our ideas may have to be modified or even abandoned. Modern science does not deal in absolute truths, but in explanations that are known to be approximations in accord with our present knowledge. There is an important principle here for our teaching - that the teacher should not hand out "facts" that go far beyond the evidence the children have been able to collect. For example, the class may decide with help, that air in bicycle pumps, tyres, balloons, and plastic bags is "squashy". It is certainly not scientific, with young children of primary school age, to talk about molecules and the space between them.

Children need experiences that will help them to form general ideas. For example, if children are to gain an idea of liquids they need to experience many different liquids - not only water, but also oil, detergent, vinegar, honey and others.

The experience should be direct, with each child, so far as it is possible, working personally with the materials.

Children should be encouraged to express the ideas that they develop during their activities. To do this they may paint, make models, and, almost certainly write. The actual doing of these things is not simply a form of expression or a communication of ideas; such activities represent ways in which the child forms ideas and then makes them part of his range of concepts.

(Science is a social activity.) It arose from man's efforts to understand and/or bring into order the information obtained from the environment, and then use this information to make his life easier. When children work together to make bricks or grind wheat they are gaining some understanding of an aspect of science. Much of the stimulus to scientific thinking comes from this interaction resulting from working together at the problems that arise. Group discussion is an important part of science."

Given this type of experience the child will develop a knowledge of a wide variety of things in his environment. It is hoped that at the same time he will develop certain abilities, for example:

Sensory discrimination.

The child becomes aware that there is more to observation than just looking. Place an object in front of a young child and ask him to look at it and tell you something about it. He will probably use his sense of sight only. He will give you a name for the object and describe its colour. One of the aims of the primary science course is to develop the child's ability to discriminate between objects using whichever of the five senses may be appropriate.

Observation.

Using the appropriate senses, the child moves toward accuracy and fullness in his observations. More harm than good may be done, however, by a teacher insisting on too high a degree of accuracy in a child's description. Much of what the child describes may be concerned with how he feels about something. His emotions are important to him and should not be ignored or suppressed by the teacher. If, in describing a worm, a child is more concerned with talking or writing about the "creepy" feeling it gives her when she holds it in her hand, rather than with any real physical characteristics of the worm, then this is what the teacher must accept. The move towards accurate, objective observation is slow and the level of achievement varies greatly.

Grouping and Categorizing.

In the past it has been common practice in primary schools (and perhaps in many secondary schools) to be satisfied with observation as the final goal. For example, in nature study it was often considered sufficient if a child could describe the colour, shape, size number of legs etc. of a particular creature. Hence nearly everyone remembers such mind elevating details as "insects have six legs, spiders have eight". This was about as far as we went with categorization. Moreover, the category was one chosen by the teacher. At the end of a forty-five minute lesson the children had learned to count legs and draw flies.

One of the most popular activities in the field of categorization is the classification of rocks. What is it that immediately springs to mind? Do you think of words such as metamorphic, igneous, sedimentary?

This is not for the primary school. Neither is indentification the goal, although children, and some teachers, seem to have a compulsive urge to name every rock that enters the room. (The old alchemists would be delighted by the transformations which take place in the classroom). Quartz becomes marble, anything yellow is gold, and chips of common house brick gain exotic names gleaned from the catalogue at Tiffany's and/or bring into order the information obtained from the environment, and then use this information to make his life easier. When children work together to make bricks or grind wheat they are gaining some understanding of an aspect of science. Much of the stimulus to scientific thinking comes from this interaction resulting from working together at the problems that arise. Group discussion is an important part of science."

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Greater success is attained when children are challenged to look for similarities and differences which will enable them to group the rocks. Younger children may make groupings such as;

"I like these"

"These are all brown"

"These are mine"

"'Cos they look like a beautiful smell"

Older children show greater discriminating ability;
"Smooth" "Soft" (Often confused)

"Its quite smooth except its got a couple of lumps on it"

"This duster can go with that nugget box 'cos you can put some of that nugget on it and then you can brush your shoes."

The children show much more imagination than adults, and the challenge of looking for new categories keeps them interested and alert.

Measuring.
This is one area where the difference between primary and secondary school science is quite marked. The younger primary school child in particular has little skill in measuring. Pounds, ounces, grams, litres, even feet and inches are beyond him. Informal units are used. The move towards using formal units and developing accuracy is slow, and best achieved through a wide variety of concrete experiences.

Thus, over many years, the primary school child is expected to develop some skill in collecting information (data, if you prefer that term). At the same time it is hoped that he will develop the ability to organize information.

Organizing Information.
The child gradually improves his ability to organize information. There is no set, teacher imposed format for this. Generally, however, the child learns to make up tables, and through his work in mathematics, to draw simple graphs.

Inference.
Inference creates a problem. The primary school child can jump to the most unlikely conclusions and cling to them quite dogmatically.

Testing Ideas.
Because the child can make such wild jumps from evidence to inference he is encouraged to look critically at his own ideas and those of other children in the class. Science deals with approximations to the "truth". The child therefore needs to be tentative in forming ideas, and should realize that he may be only partly right, or even quite wrong.

Take the following example of a fairly typical experiment involving observation and inference.
The child wrote,
"I mixed vinegar and baking soda. A gas came off. It was called carbon dioxide"
The name of the gas must have been supplied by the teacher, and is, in the context, a piece of information with practically no value at all. The child went on to say, incorrectly,
"The carbon dioxide comes from the vinegar."
How much better it would have been if he had said,
"I <u>think</u> that the carbon dioxide comes from the vinegar."
It would be hoped that he would eventually go even further and realize that further tests are required in order to verify or modify his ideas.

Thus, in primary school science, the child is given the opportunity to investigate his environment, to try to bring some order to his understanding of the environment, and to develop the ability to think critically, actively and flexibly rather than be a passive recipient of his teachers wisdom or ignorance.

One thing of vital importance remains to be said. Primary science is not an isolated subject. <u>Language</u> is important as a means of communication and as something intimately involved in thinking, and particularly in the development of concepts. Primary school science involves practically any other subject you care to name - mathematics, art, social studies, literature, music, physical education, etc. It is not restricted to the laboratory or the classroom, but makes the fullest use of the environment.

An example of science in grade six.

Topic: "Threads and Fibres"
The following aspects were investigated;

- testing the strength of threads.
- effects of household chemicals.
- effects of water - rotting.
- effects of weather.
- effects of heat.
- threads and fibres in nature.
- spinning threads from fibres.
- dyeing.
- weaving.

Children testing the strength of threads recorded the following comments,

"First we organized ourselves into a group of six. Kerry was the leader in our group. We wanted to test how many pounds and ounces it took to break various plies of wool. Here you will see how we set it out.

Wool	Colour	Weight
3 ply	brown	5 lb.
3 ply	red	5 lb. 14 oz.
4 ply	yellow	6 lb. 1 oz.
4 ply	green	6 lb. $6\frac{1}{2}$ oz.
8 ply	black	20 lb.

In the weight column you will see how much weight it took to break the wool. We found this out by bringing tins from home to put the weights in. We fixed the wool onto the tin and wound the other end of the wool around rulers. We dropped the weights in one at a time until the wool broke and then we counted the weights and wrote it all down. We did it another way with dirt. All we had to do was weigh it.

(The teacher could not resist the temptation to ask if red wool was always stronger than brown, and of green was always stronger than yellow. This sparked off a whole new line of investigation.)

Other comments from the children which led to much discussion and further investigation were,

"We had to do our experiments again because we forgot to set the scales at nought"

"Kerry and Jan said we shouldn't have dropped the weights in the tin but we said it didn't matter."

"Four ply wool broke at six pounds weight when dropped in roughly. But when the weights were carefully placed in it broke at 7lb. 2oz. weight."

"I think that the longer the wool is, the harder it should be to break because when it is short it can't stretch much and therefore it breaks"

"A long piece of wool should break before a short piece because it is heavier."

"The different ...

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"A long piece of wool should break before a short piece because it is heavier."

"The different cottons and wools seemed to break strand by strand rather than all at once."

"When we used nylon V.B. (venetian-blind) cord it took six stone six pounds to break it. When the nylon V.B. cord was breaking we could hear the threads breaking, too. They were making a tingling noise. They went ping, ping, ping, ping, ping."

"The cord seemed to get weaker the longer we left weights on it."

"At one time we thought the cord had broken when the knot had only slipped."

" .... but the tin handles cut the string when we placed only one brick in the bin so we tied it around the bin itself and it held two bricks before it broke."

"The last thing we put in the bucket was a whole brick. Then the cord broke. We weighed the bucket of bricks. I said our answer mighr be wrong because it might have broken if the last thing we had put in was only a bit of brick. It would have broken if we had put an elephant in the bucket, too, but that wouldn't give the right answer."

A Cooperative Pollution Study

Mr. John Vince of the School Forestry Branch of the Education Department spoke after Mr. Verso.

Mr. Vince described a cooperative study which he had organized amongst schools in the Yarra Valley. Both Primary and junior Secondary students were involved in this venture and between them achieved a great deal.

Basically, the programme was organized on "local responsibility" lines. Each of the involved schools took an area of the river close to the school buildings and investigated a number of characteristics according to a predetermined plan. Each school investigated the following characteristics:

1. Water temperature.
2. pH.
3. Debris.
4. Effluents draining into the river.
5. The aquatic plants and animals.

As well, schools took samples of river water and forwarded them to Mr. Vince for analysis of "coliform" bacteria contents.

All of the information obtained was coordinated by Mr. Vince and drafted into a report. This report was then duplicated and returned to the participating schools.

Teachers in the participating schools used the venture either one of two ways. Either the venture was used as a starting point for a study of pollution or the venture was used to give practical application to existing discussions or teaching.

A detailed report of this venture is to be found in The Educational Magazine (Vol. 28, No. 3, April, 1971)

SECTION 3. CLASSROOM ACTIVITIES.

A considerable amount of conference time was devoted to the sorts of classroom activities which might with profit be included in an Environmental Studies programme. Materials for five activities were set up by the conference organisers and participants were able to actually do the data gathering involved. These activities were specifically chosen to demonstrate some of the crucial points associated with experimental work in Environmental Studies. The four main points considered by the Committee were:

1. the variability of the results obtained from data collection.
2. the need for criteria in the interpretation of data.
3. the fact that criteria used in interpretation of data usually involve value judgements.
4. the fact that experimental work in Environmental Studies involves knowledge, skills and abilities derived from areas of activity associated with various disciplines.

Prior to the sessions involving student activities participants were provided with a description of six different activity ideas. These six ideas are reproduced below.

1. Measurement of Atmospheric Solids

This is a particularly fruitful exercise when done as part of a survey of some nature. Simply measuring atmospheric solids, whilst interesting, tends to be rather unproductive.

Estimates of the amount of solids in the atmosphere may be obtained either by exposing clean petri dishes, or exposing petri dishes containing a very thin layer of plain water agar to the atmosphere. It is advantageous to use both types of dishes because of the different effects they seem to have. Materials tend to be blown into and out of the clean petri dish on windy days whereas the agar tends to trap most materials blown into the dish (Note that the dishes should be left open for a standard period of time to allow comparability of results.) Examination of particles may be carried out using a microscope and a prepared piece of graph paper (i.e. a piece of graph paper from which squares have been removed in a systematic pattern to provide a sampling grid. The sampling grid will need to be developed by trial and error to suit local communications.) The petri dishes are placed on the graph paper, on the stage of the microscope. Probably the most fruitful use of solids estimation is in establishing correlations with weather patterns over a period of time or in extablishing correlations with geographical locations. (In the city ordinary street maps are adequate; in the country Army Ordinance maps are probably most adequate.)

A further extension that may be introduced is to classify solids according to particle size and attempt to investigate patterns of particle deposition over a geographical area.

This exercise is useful in giving practice in hypothesis formation and testing. Note. There is no criterion involved here which will allow students to make judgements about the quantity of solids in the atmosphere. The published criteria are all in terms of mass of solids and/or the types of solids and are not really applicable in this exercise.

Sterifil Millipore Equipment

This equipment could be a useful aid in gathering airborne and waterborne pollution material. The equipment involves a series of filters, and a filter holder assembly which is coupled to a vacuum source.

The manufacturers maintain that this equipment is useful for a number of experiments - a few of which are listed below.

(a) Gravimetric and Patch test analysis of water or air.

(b) Particle counting analysis (using grid filter paper.)

(c) Pollen counting.

(d) Microchemical analysis of particles in urban air.

(e) Analysis of cigarette smoke.

(f) Analysis of Radioactivity - with the aid of a Radiation Detector.

Each of the above experiments is described in detail in a manual which can be obtained from the distributors of the equipment. Some modifications and alterations to method could well be necessary to obtain the degree of accuracy necessary for valid conclusions to be drawn.

2. Estimation of the Carrying Capacity of Roadways

This exercise is primarily for students living in cities or towns, but country students living on main highways may also find it interesting.

This technique may be applied in many ways e.g. to various points on the one road to one point on each of several roads, or to the one point on the one road at various times of day.

Bottlenecks, e.g. traffic lights or roundabouts should be avoided as they make the technique too difficult for students.

Measure out a stretch of road between 30 feet and 100 feet long (the longer the better, within limits) and station observers and recorders at each end and in the middle of the section.

Count the number of cars passing through the trap in, say five minutes.

Time how long it takes several of the cars above to pass through the trap.

Calculate the mean time of passage of cars through the trap.

Calculate the rate of flow of cars by dividing the total number of cars passing through the trap by the amount of time the observations were carried on for.

Calculate the concentration of cars. This is done by dividing (mean time of passage of cars X total number of cars) by (total time of observation X the length of the trap.) Note: Students will probably need assistance with units in these calculations.

Plot a graph of rate of flow versus concentration of cars. Points should fall on a curve. If the curve shows an inflexion then the point on the top of the curve is the optimum capacity of the road. (This does not mean, however, that the optimum performance rate for the road is good enough.)

3. Examination of Air Pollution Data

A very graphical presentation of what is probably the most well known example of a "smog" problem is to be found in Interim Report of U.K. Committee on Air Pollution (Beaver Committee), 1953. This has been reproduced on page 25 of reference 1.

The graph and its label provide a very good instrument for class discussion. It also gives students good exercise in the analysis and interpretation of graphical data.

Examples of questions which might be posed are:

1. Did the sulphur dioxide cause deaths?
2. Is there any correlation between temperature and increase in SO_2 and smoke concentrations?
3. What relationships might exist between SO_2 and smoke concentrations?
4. What relationships might exist between fog, smoke and SO_2 in this context?

4. Estimation of Smoke (Haze) Density

The normal technique employed for measuring smoke density requires very sophisticated laboratory apparatus.

A qualitative technique which may be employed uses cards similar to those reproduced at the end of Appendix II.

The technique involves waiting for a clear day and then establishing "calibrations" of the technique. Two students, an observer and an assistant work together using the four cards. The assistant takes a card 4 and walks away from the observer, making sure that the card is always visible to the observer. When the observer can no longer see white on the card the assistant then moves several feet further away, holds up card 4 again, and walks slowly towards the observer. When the observer can just begin to see white on the card the assistant stops and the distance between assistant and observer is again measured. The mean of the two measurements is then the "working distance" for all further observations.

Observations are made by the observer and the assistant standing separated by the working distance, and the assistant holding up cards at random (1, 2, 3, and 4.) The card on which the observer can just distinguish white is the qualitative value given to the smoke density (i.e. 1, 2, 3, or 4.)

Alternatively, the assistant may use only card 4, starting at the working distance between the assistant and the observer. The assistant walks towards the observer and stops at the point at which the observer can just distinguish white on the card. The distance is taken as the quantative value for air translucency (or smoke density - whichever way the teacher wishes.)

The data obtained is most useful when correlated with weather conditions.

This exercise will need to run for a considerable time in order to provide sufficient data.

Measurements should be made at the same time of day to allow some comparability of light intensity.

Teachers may find it convenient to introduce some elementary statistics for the treatment of obtained data.

5. Observation

Environmental study is an observational science. As most measurements are taken from nature, accuracy in observation will be essential. Some consideration must therefore be given to the nature of errors, so that they may be eliminated if possible or allowed for if not.

Classification of Errors

(i) Blunders. These are usually large and often easy to trace. For example a surveyor may make an error of 10° in reading his instrument. When recording he may write down 34° instead 43°.

(ii) Systematic errors. There are errors brought about by inaccuracy in the instrument being used. For example a tape may be inaccurate. It is necessary then to test the instrument for accuracy prior to observing.

(iii) Periodic errors. The distinguishing feature is their tendency to vary in a periodic fashion. A compass needle has a slight daily variation in direction. Such an error should be shown as a sine curve.

(iv) Personal errors. These are characteristics of individual observers. One man may be more casual in his readings than another. For example when scales have to be read under a lens, some observers may omit to allow for parallax

(v) Random errors. Factors such as wind gusts, shaking an instrument; poor visibility may blur the outline of a distant object thus producing random errors. Often these errors cancel each other out.

How accurately can you observe? A few simple Tests.

Test I Weight. Using a graduated set of known masses have each member of the class estimate the weight of an unknown mass given access to the known masses. Each member should then estimate his percentage error on the true weight.

Test II Length. Each class member should attempt to estimate some previously measured length or distance.

Test III Time. Members of a class could be asked to write their estimate of a period. They begin with (GO) and are stopped with (STOP!) by someone equipped with a watch.

Test IV Angle. Choose a point (A) at one end of the classroom and have the class members individually estimate the angle (0) that is subtended between a horizontal line at eye level and a line joining a point (B) above eye level.

The results should be written anonymously on pieces of paper.

Measure the angle using an inclinometer ensuring that allowances are made for height differences in the class.

Text V Memory. Efficiency in memorizing observations can be tested by allowing the class to experience a number of varying activities.

examples: (a) Sound of a tuning fork (particular frequency)

(b) Shade of colour

(c) Construction of figures

(d) Short sentence

Next day test the class to assess their degree of retention.

6. Meteorology and Climatology

As a follow up to the exercise on observation, it may be advisable to lead into a study of meteorology - an essential part of which is observing and recording.

It would appear that any worthwhile study in this field would need to be conducted over a prolonged period (e.g. two seasons) in which students could roster themselves to take observations and record.

The following headings are examples of measurements which could be made in a "School Meteorological Station".

Date:	Soil Temperatures
Time:	Precipitation (ins)
Barometer: (Barograph)	Wind
Screen Temperatures	Force (Anemometer)
Dry bulb	Direction
Wet bulb	State of Ground
Relative humidity	Visibility
Maxima } (Thermograph)	Cloud cover
Minima } (Thermograph)	Remarks:

It would be perhaps advisable to employ two books for recording

(1) for entry of observations when they are made

(2) a copy for preservation

The "Remarks" column might include comments or variations in visibility in different directions, remarkable events during the past 24 hours and suspected unreliability of certain observations.

References

1. The Parliament of the Commonwealth of Australia 1969
Parliamentary Paper No. 91.

Report from the Senate Select Committee on Air Pollution - Part I Report
Commonwealth Government Printing Office.

2. The Parliament of the Commonwealth of Australia 1970
Parliamentary Paper No. 98.

Report from the Senate Select Committee on Water Pollution
Commonwealth Government Printing Office.

3. Rigg, J.B. A Textbook of Environmental Study
Constable, London, 1968.

Three of these activity ideas, numbers 1, 2 and 5 were employed during the sessions. The other two activities involved the use of "Millipore" apparatus. The procedures followed in the five activity sessions are set out below; the results of these activities may be found in Appendix II.

Activity 1. Measurement of Atmospheric solids.
The area of Melbourne City proper was divided into a grid and fifteen "stations" established (See grid in Appendix II.) Six Petri dishes were exposed at each station (Three sterile and three containing water agar) for a period of thirty minutes. Station 1 to 5 were exposed simultaneously, stations 6 to 10 simultaneously thirty minutes later, and stations 11 to 15 thirty minutes later again. The numbers of particles of these Petri dishes (5 cm. diameter) were counted under low power magnification of a monocular microscope.

Activity 2. Estimation of the Carrying Capacity of a Roadway.
On consecutive mornings observation teams went forst to the Tullamarine Freeway and then to Johnson Street in Collingwood to make the observations described in idea 2 above, (See Appendix II) The length of trap employed was 570 feet. Participants were asked to plot graphs of rate of flow versus concentration of cars and then interpret the graphs.

Activity 3. Observation: Errors and Measurement.
Four different tasks were developed by the conference organisers and set up in a room before the beginning of the session. Participants were required to complete the tasks one after another and at the end of the session compare their results. This session was deliberately designed to demonstrate the common illusions and perceptual errors which can occur when people are making observations. The worksheets for this activity explain the tasks carried out by participants. (See Appendix II.)

Activities 4 and 5. Water Analysis.
Samples of sea water were collected from Port Phillip Bay and samples of fresh water were collected from the Yarra River. On the day prior to the conference bacteria (coliform) cultures were prepared using the "Millipore" technique. Three replications were set up from each sample of water and cultured overnight.

During the sessions the pH of each sample was measured and recorded.
In the session dealing with the sea water participants counted coliform colonies per plate and titrated the sea water to determine the carbon dioxide concentration (.1M HCl, Methyl Orange indicator).
In the session dealing with the fresh water participants counted coliform colonies per plate and titrated the fresh water to determine the "chloride" concentration (.1M $AgNO_3$, Mohr's titration).

After each session participants were asked to discuss the "meaning" of their results. (See Appendix II)

Discussion Following the Activities.

All discussions were deliberately slanted to take in the four points mentioned at the beginning of this section. The members of the Secondary Science Committee considered that this course of action was quite justified, in that these points must be clearly in mind in all empirical work that students undertake. Although only a subjective judgement, some members of the Committee feel that participants at the conference were in substantial agreement with this view.

To assist teachers in the development of their own classroom activities lists were compiled of some references, reading materials, journal and magazine articles, and people and organizations interested in the environment. Three lists are reproduced below.

A Selection of References Containing Ideas for Student Activities.

I. Scientific Experiments in Environmental Pollution. E.C. Weaver.

This book is completely concerned with pollution. It contains a number of suggestion of activities in which students actually set out to detect and measure the level of various forms of pollution. The activities in this book are very heterogeneous in difficulty.

II. Modern Earth Science. Ramsey, Burckley, Phillips and Watenpaugh.

This title is, in fact, a teaching system. There is a text, teachers' version of the text, activities manual entitled Activities For Modern Earth Science, teachers' version of the activities manual, laboratory manual entitled Laboratory Experiments For Modern Earth Science, teachers' version of the laboratory manual, and a booklet of tests entitled Tests For Modern Earth Science.

The system contains six units:

(1) The Earth in the Universe.
(2) The Planet Earth.
(3) Forces That Sculpture the Earth.
(4) The Earth's Envelope of Water.
(5) The Record of Earth History.
(6) The Earth's Atmosphere.

The teachers' edition of the text combined with the teachers' edition of the activities manual will provide many useful ideas for student activities. (Sections of the activities manual headed "Research Activity" will be found more useful than those headed "Review Activity". Both types of activity are keyed to the teachers' edition of the text, so the text will provide a useful reference for teachers. The laboratory manual, also keyed to the teachers' edition of the text, contains some useful ideas too, but materials may be difficult for teachers to obtain.)

III. Discovery In Science. (Victorian Edition) Baldock et al.

Both books, Forms III and Form IV, contain useful ideas for student activities.

IV. The Teachers' Handbook For Environmental Studies. Perry, Jones and Hammersley.

This book is the basic reference book for a series known as the Approaches to Environmental

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There are, at the moment, six books in the series plus a teachers' guide.

1. Towns and Town Life.
2. The World of Water.
3. Weather and Life.
4. The Air We Need.
5. Farms and Farm Life.
6. Roads and Road Transport.

Plus, Teachers' Guide No. 1. (which is a guide to the above six books.)

None of these books were available for examination at the time of writing, only the teachers' handbook, so it is difficult to comment on their usefulness. The handbook does contain some useful ideas for early secondary, but these will take some considerable development before being put into practice as student activities.

V. Millipore: Experiments in Microbiology. Millipore Corp. (Available fro, H.B. Selby P/L for approx. $0.80.)

This booklet contains a series of nine experiments involving Millipore apparatus. The experiments provide some good ideas for the investigation of micro-organisms and particles in water and air.

VI. Investigating the Earth. Earth Science Curriculum Project.

This title is the published part of the teaching system produced by the E.S.C.P. There is a text/laboratory manual intended for student use and a teachers' guide in two parts.

As well as the text/laboratory manual and teachers' guides there exist a very wide range of supplementary material. This material is detailed in an appendix to teachers' guide part 1. (N.B. This list is relevant to the United States and not necessarily Australia.)

Materials for use in laboratory activities have been produced in the United States in kit form. These kits would obviously be very expensive in Australia so teachers will find the lists of apparatus for use in each laboratory activity particularly useful. (These lists are to be found in the teachers' guides as part of the discussions of each activity.)

The E.S.C.P. course is broken into four units:

1. The Dynamic Earth.
2. Earth Cycles.
3. Earth's Biography.
4. Earth's Environment in Space.

Very many useful ideas for student activities investigating their environment may be found in this course.

VII. A Textbook of Environmental Studies. J.B. Rigg.

This book is simply a collection of ideas for student activities. Some sections are better than others. The following sections show definite potential for development.

Clouds. pp. 47-54.

Meteorological and Climatological Instruments. pp. 70-87.

Considerable information regarding the types of instruments available, and the methods involved in calibrating and building some of these. A large number of ideas for activities.

On Using Other Peoples' Records. pp. 88-92.

Useful ideas on approaches to second-hand data.

Minerals. pp. 127-138.

Fossils, Geological Time Scale, Rock Identification and Geological Maps, Pebbles and Fragmental Rocks, Soils. pp. 139-191.

A quantity of background information and some clues for converting this into student activities.

Oceanography, Practical Oceanography, Ground Water Run-off, Gauging Rivers and Streams. pp. 192-246.

Background information of use to teachers in appropriate areas.

Land Utilization. pp. 260-263.

Overlaps with Geography. Some useful ideas particularly for introducing the topic.

The Urban Environment. pp. 264-270. As above.

- A SELECTION READING MATERIALS

AUTHOR	TITLE	PUBLISHER
Australian Conservation Foundation	Conservation Directory.	A.C.F.
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Carson, R.	The Silent Spring.	(Various editions)
Cox, G.W.	Readings in Conservation Ecology.	Appleton, Century, Crofts.
Goodman et al. (Eds.)	Ecology and the Industrial Society.	
Herber, L.	Crisis in Our Cities.	Prentice-Hall..
Herber, L.	Our Synthetic Environment.	Prentice-Hall.
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Hoopes, R.	A Report of Fallout in Your Food.	Signet.
Joffe, J.	Conservation: Interdependence in Nature.	Aldus Books.
Johnston, V.	Natural Areas for Schools.	State Department of Natural Resources Sacremento, Cal.
Lanwergs, J.A.	Man's Impact on Nature.	Aldus Books.
Marshall, A.J.	The Great Extermination.	Heinemann.
Mellanby, K.	Pesticides and Pollution.	Collins.
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Proc. of Univ. of New England.	Conservation in Education. Seminar 1966.	University of New England.
Reed, K.	Nature's Network.	Aldus Books.
Serventy, V.	A Continent in Danger.	Deutsch.
Serventy, V.	Australian Wildlife Conservation.	Angus & Robertson.

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Stapp, W.B.	Integrating Conservation and Outdoor Education into the Curriculum.	Burgess Publishing.
Stephenson, W.L.	Living Place and Living Space.	Angus & Robertson.
Stephenson, W.L.	Places for Living.	Angus & Robertson.
Senate Select Committee on Air Pollution.	Air Pollution Part 1 - Report.	Government Printing Office.
Senate Select Committee on Water Pollution.	Water pollution in Australia.	Government Printing Office.
Webb, L.J. et al.	The Last of the Lands.	
Whitten, J.L.	That We May Live.	Van Nostrand.

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Publication	Vol. No.	No.	Date	Article Title
	220	3	March '69	Thermal Pollution and Aquatic Life.
Scientific American	220	4	April '69	Soil Pollutants and Soil Animals.
		4	April '70	Pesticides and the Reproduction of Birds.
			May '70	The Calefaction of a River.
			March '67	Toxic Substances and Ecological Cycles.
			July '67	Third-generation Pesticides.
	6	1	Jan. '70	End of the D.D.T. Decade.
Science Journal (U.K.)	5A	2	Aug. '69	The Everglades - a Threatened Ecology.
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	4	12	Dec. '68	Biological Control of Pests and Weeds.
	5A	6	Dec. '69	Reclaiming the Marginal Lands.

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Stephenson, W.L.	Living Place and Living Space.	Angus & Robertson.
Stephenson, W.L.	Places for Living.	Angus & Robertson.
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Webb, L.J. et al.	The Last of the Lands.	
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Publication	Vol. No.	No.	Date	Article Title
	220	3	March '69	Thermal Pollution and Aquatic Life.
Scientific American	220	4	April '69	Soil Pollutants and Soil Animals.
		4	April '70	Pesticides and the Reproduction of Birds.
			May '70	The Calefaction of a River.
			March '67	Toxic Substances and Ecological Cycles.
			July '67	Third-generation Pesticides.
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	4	4	April '68	Isolated Island Communities.
	44	670	Oct. '69	How Air Pollution Alters Weather.
New Scientist (U.K.)	44	680	Dec. '69	Crisis Year for the Great Lakes.
	44	676	Nov. '69	Against Food Pollution.
	44	673	Oct. '69	Doomsday for Coral?

Publication	Vol. No.	No.	Date	Article Title
New Scientist (U.K.) CONT.	43	668	Sept. '69	Can Britain Afford to be Clean?
	43	667	Sept. '69	Closer Watch on River Pollution.
	43	664	Aug. '69	Industrial Dereliction and Britain's Beauty.
	43	662	Aug. '69	Escalation of Chemical Warfare.
	42	652	June '69	Has Nuclear Testing caused Infant Deaths?
	45	688	Feb. '70	Oil Pollution January, 1970.
	45	689	Feb. '70	Milestones for Conservation.
Science Education (U.S.A.)	53	3	April '69	Conservation Education Today and Tomorrow.
	51	5	Dec. '67	How Man has Changed the Planet.
	49	4	Oct. '65	Forrest Olin Capps, Sr.
	49	4	Oct. '65	A Suggestive Plan of Action for State Level Co-ordination in Conservation Education.
	49	3	April '65	Our Job as Conservation Enthusiasts.
Rural Research (C.S.I.R.O.)	66		June '69	Conserving Australia's Waterfowl.
	66		June '69	Learning to live with Kangaroos.
	69		March '70	The Bushfire Problem in Australia.
Riverlander			Feb. '70	Bad Earth Page: Poison Rampant.
			Jan. '70	"Wasteful Butchery" of our Kangaroos.
			Nov. '68	How to Narrow the Need for Pesticides.
			Jan. '67	Wildlife: But will there be any left?
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			Aug. '66	S.A. Care of Wildlife: Verdict - "Dismal."
			Nov. '69	Growing a National Park.
			May '70	Pollution Points.
Science Education News (N.S.W.)	18	1	May '69	Conservation Education. (V. Serventy)
Port Gazette Melb. Harbour Trust.	9	9	Feb. '70	Prevention of Pollution.

Publication	Vol. No.	No.	Date	Article Title
Lab Talk		6	July '67	Should we teach Conservation?
Australian Sci. Teachers' Journal.	14	3	Nov. '68	Marine Pollution.
Victoria's Resources.	9	4	1968	Control of Atmospheric Pollution.
Life.	Educational Reprints		'69	Air Pollution.
	Educational Reprints		'69	Water Pollution.
Aust. Journal of Science.	28	9		Approaches to Conservation. E.C.F. Bird.

Note. These lists were completed in January 1971. Since then a number of useful and informative references and books have become available. In particular, a number of very worthwhile articles have appeared in some of the publications listed in Journal and Magazine References.

Organizations, Persons or Government Departments Interested in Conservation and Its Influence upon the Community.

Australian Conservation Foundation,
191 Royal Parade,
Parkville. 3052.

Natural Resources Conservation League,
Springvale Road,
Springvale. 3171.

Forests Commission of Victoria,
Treasury Place,
Melbourne. 3002.

Fisheries and Wildlife Department,
605 Flinders Street,
Melbourne. 3000.

National Parks Authority,
Treasury Place,
Melbourne. 3002.

Soil Conservation Authority,
378 Cotham Road,
Kew. 3101.

Health Department,
295 Queen Street,
Melbourne. 3000.

Land Utilization Advisory Council,
378 Cotham Road,
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Journal.

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Land Utilization Advisory Council,
378 Cotham Road,
Kew. 3101.

Vermin and Noxious Weeds Destruction Board,
Treasury Place,
Melbourne. 3002.

Melbourne and Metropolitan Board of Works,
425 Collins Street,
Melbourne. 3000.

State Rivers and Water Supply Commission,
99 Orrong Road,
Armadale. 3143.

Town and Country Planning Board,
235 Queen Street,
Melbourne. 3000.

C.S.I.R.O.,
314 Albert Street,
East Melbourne. 3002.

Forestry and Timber Burear,
460 Bourke Street,
Melbourne. 3000.

Gould League of Bird Lovers,
State School,
Samarinda Avenue,
Ashburton. 3147.

Mobil Oil Australia,
2 City Road,
South Melbourne. 3205.

Native Plants Preservation Society of Victoria,
3 Denham Place,
Toorak. 3962.

Save The Dandenongs League,
Kakirra,
Kalorama. 3766.

Blackburn and District Tree Preservation Society,
168 Central Road,
Nunawading. 3131.

Victorian Field and Game Society,
(President; D. Hemingway.)
330 Sydney Road,
Brunswick. 3056.

Water Research Foundation,
St. Kilda Road,
Melbourne. 3004.

Birds Banders' Association of Australia.

River Murray Commission.

N.S.W. Department of Flaura and Fauna.

Society for Growing Australian Plants.

Bird Watchers' Association.

Kangaroo Protection League.

Field Naturalists' Associations.

SECTION 4. AUDIO-VISUAL MATERIALS.

Mr. J.R. Northfield of the Secondary Teachers' College conducted a session on audio-visual materials available for use in the teaching of Environmental Studies. Because of the relative novelty of interest in the environment few audio-visual materials are readily available to teachers. Much of the material that is available is straight-out propaganda, which is excellent in its place

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To assist teachers Mr. Northfield prepared a list of films, film-strips and slides. This list is not comprehensive but contains materials which Mr. Northfield felt teachers may find valuable.

FILMS.

"Problems of Conservation" Series.
Our Natural Resources. (Available from AVEC film library.)

Air. (Available from AVEC film library.)

Water.

Minerals.

Forest and Range.

Wild Life.

Soil.

The above films are recent Encyclopaedia productions. Only those indicated are in the AVEC film library. Scripts for these films are available from:
Encyclopaedia Britannica Inc.,
Education Division,
Box A 244,
Sydney South, N.S.W. 2000.

Other films from Encyclopaedia Britannica are:

The House of Man: Our Crowded Environment. (Available from AVEC.)

The Garbage Explosion.

Two films E.B. have in production are:

The New Pollutions.

Noise: An Assault on Our Senses.

Two other films available from the AVEC film library which may be of interest to teachers are:

The Shadow of Progress. (Produced by B.P.)

The Pond and the City.

FILMSTRIPS.

Ward Natural Science Set (No. 70 W 3800)

Nature of the Crisis.

Atmospheric Pollution.

Land Pollution.

Freshwater Pollution.

Marine Pollution.

Pollution Control.

Drugs in Our Society set (2 titles.)

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Pollution Control.

Drugs in Our Society set (2 titles.)

Both of the above sets are available from:

Educational Media,
201 Park St.,
South Melbourne. 3205.

Encyclopaedia Britannica also produces a series entitled "Environmental Science" which are available from the address given under the heading - Films.

SECTION 5. THE FINAL SEMINAR.

The final seminar session was devoted to Environmental Studies programmes in schools. Seminar groups were at liberty to discuss any aspect of this topic that they should choose. A remarkable diversity of approach came out of this session - three groups devoted their time to the problems of implementing Environmental Studies in the curriculum, one group developed a list of ideas for "limited extent studies" either as part of a special programme, and one group devoted its time to developing a four year science course with a distinct Environmental Studies bias.

Prior to this seminar session all participants were provided with four study papers. These four papers are reproduced herein.

Study Paper 1.

THE MAIN IDEAS TO BE DEVELOPED IN ASEP MATERIALS.

(The organiser of this conference are grateful to ASEP for permission to reproduce this document.)

1. The main ideas developed in the ASEP materials will be influenced by many factors. Some of these are:

1.1 the experience and judgement of development staff

1.2 knowledge of the abilities of teachers and their needs

1.3 knowledge of available facilities

1.4 knowledge of the abilities of the children concerned.

Such factors will generally be used as bases for exclusion of certain ideas or for choice among alternatives. In this paper only bases for inclusion of ideas are dealt with.

2. Five sources of ideas were examined.

2.1 The child's environment and his understanding of it.

2.2 The content of science i.e. present scientific knowledge.

2.3 The nature of science, as revealed by its history.

2.4 Procedures used to extend knowledge, including processes of scientific investigation and communication.

2.5 Attitudes related to science and scientific investigation.

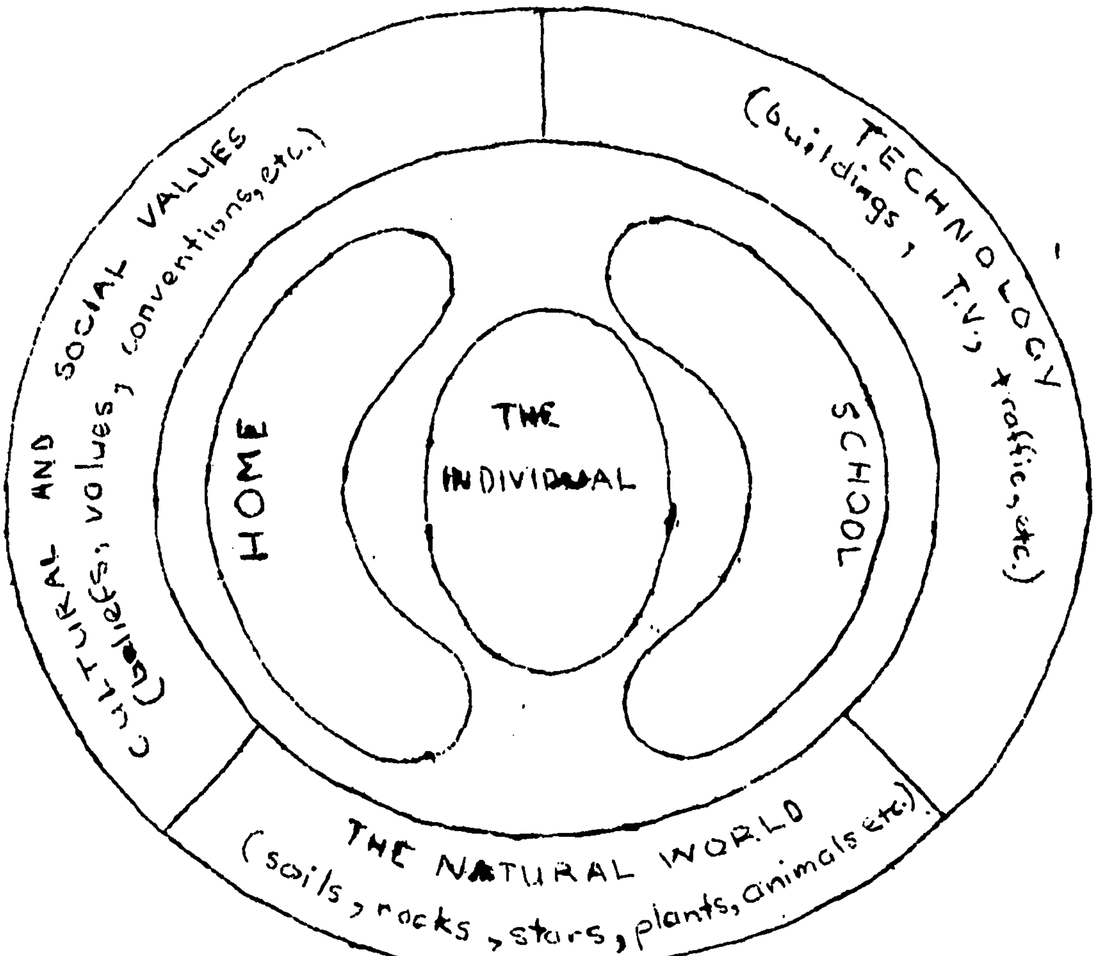
2.6 Three stages of intellectual development, from Piaget's concrete stage through an intermediate transition stage to the formal stage.

3. The main sources of ideas for inclusion in ASEP materials arise from consideration of the environment of the child, the nature of science and the present state of scientific knowledge. While some ideas may be included to promote certain attitudes or to develop certain procedures for extending knowledge or to be relevant to a particular stage of development, it is believed that these sources of ideas will be of minor importance.

THE ENVIRONMENT OF THE CHILD

4. The child's 'environment' includes all the objects, forces and conditions, both internal and external, that affect the individual.

5. The following diagram gives some indication of the ranges of sources of stimuli to which children respond.



6. Certain qualifications to the diagram are necessary.

6.1 The various components of the environment are both overlapping and interdependent.

6.2 The individual is influenced by his 'internal environment'.

6.3 The school and home components determine largely what environmental stimuli the child receives.

7. As a basis for inclusion of topics related to the child's environment a list of important ideas was organized into a scheme which is referred to here as the environmental scheme.

8. In the form stated here, the environmental scheme is expressed as adult ideas. It is intended that the ideas will be presented to children in such a way that they will be seen by the children as relevant to their present life and useful in helping them to gain an understanding of their environment.

9. Emphasis will be given to the place of the child in his present environment, leading to an understanding that man is a living organism who, like other organisms, is continually interacting with his environment, yet whose interaction can be an interference with far reaching effects. The children should learn that a study of such interactions can lead to a better understanding of the environment.

THE ENVIRONMENTAL SCHEME - AN OUTLINE OF THE MAIN IDEAS INVOLVED

10. Man must realize how he functions as an individual, compared with how other living things function; the role of groups in determining values and in making decisions concerning the use of the environment; the ways in which man has increased his ability to learn about the environment and to make use of it; how technology has affected both man and his natural environment; the changes that take place naturally in the environment and how these have been affected by the interference of man.

11. Man must realize the far reaching effects of his continued noncyclic modification of his environment, both in terms of the consequences of changes made to the environment and in terms of effects of the changed environment on man and other living organisms.

In what ways does man, the individual, resemble and differ from other individual organisms?

12. An essential part of understanding of the environment and its interaction with man is an understanding of how man functions as an individual, compared with how other living things function.

13. Man has certain life requirements for food, shelter and protection which are similar in many respects to those of all other life but which differ in other ways. Part of the difference is due to man's ability to control his environment.

14. Man's body consists of systems which function together as an integrated unit. These systems are similar in many respects to systems in other individual organisms. There is great diversity among organisms with respect to body structure and functions .

15. The systems are concerned with

- 15.1 intake and absorption of food materials
- 15.2 utilization of absorbed food for body growth and repair, and for energy
- 15.3 disposal of excess materials
- 15.4 maintenance of the internal environment including defence against disease
- 15.5 communication among body parts
- 15.6 growth to maturity and reproduction of new organisms
- 15.7 reception of stimuli from the external environment
- 15.8 movement and behaviour relative to the external environment.

How do interactions among groups affect decisions made by man?

16. Most of man's efforts to change the environment and the system of values upon which his behaviour is based, arise from group interactions rather than the needs of individuals.

17. Individuals with common interests form structured groups which establish their own goals and adopt procedures to achieve those goals.

18. Group structures differ according to patterns of work, power, communication and personal relationships. Each individual has a role to play with respect to each pattern of structure.

19. Pressures within groups affect individuals, group structure and group goals. Pressures among groups affect groups and society. In a rapidly changing society, flexibility in adopting new roles is important for individual survival.

20. Understanding of man's behaviour as a member of a social group has been gained partly through the study of group behaviour in other organisms.

In what ways has man extended his ability to explore and manipulate his environment?

21. The ability of man to learn about his environment and to make use of it has been increased by man-made devices and procedures which extend his sensory perception and mental abilities and his ability to use his own energy to move and to manipulate.

22. The accuracy, sensitivity and range of man's sensory perception has been extended by development and use of instruments and communication devices.

23. Man's capacity to learn has been increased by the organization of existing knowledge and by procedures, such as the use of theories and models, for extending knowledge.

24. The precision and speed of mental processes has been increased by the development and use of devices for processing, storing and retrieving information.

25. Man's ability to move in his environment, to move things and to perform activities, by use of forces he can exert within his own ability and energy range, has been increased by the development and use of mechanical devices, tools and machines.

In what ways has technology changed man's environment?

26. Man's desire to make the world a better place in which to live, in terms of material comforts, financial and national security, has led to great technological advances. One consequence has been an exploitation of the natural environment to the extent that man's future in his natural environment has been jeopardized. An understanding of this situation involves a knowledge of how technology has affected man and the natural environment.

27. Technology has made increasing demands on the world's resources of raw materials. Man has rapidly increased his efforts to discover more deposits of these materials, extract them from their present localities and prepare them for use.

28. The search for raw materials has been accompanied by a search for synthetic substitutes and for new materials that will better serve the purpose desired.

29. Technological advance has depended on the development of better machines and the availability of energy at reasonable cost. This has led to a search for new energy supplies and the development of procedures for making energy more readily available. Devices to transform energy into usable form have been developed.

30. Technological society has required the rapid movement of energy, men and goods from place to place. Transport and transmission facilities have been developed to cope with this requirement.

31. Technology has led to improvement of man's material comforts - housing, appliances, working conditions, clothing, hygiene, leisure activities.

32. Man's health has benefited from improved food production due to better land management and usage, improved processing methods and better techniques for prevention, control and treatment of disease and body disorders.

33. One area of technology is concerned with space research which includes the establishment of artificial satellites. A significant portion of this area has developed from defence requirements.

34. Associated with technological advance there has been depletion of natural resources and addition of pollutants to the environment.

What changes in the environment take place naturally? How has man interfered with these changes?

35. The impact of man upon the natural environment can only be understood if the changes that take place naturally are known. Man should realize that he occupies only a small place in the universe but his effects on the earth and the life on it are far reaching.

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36. Living organisms exist in ecosystems in which a balance exists among the various organisms present and their physical environment.

37. The materials and structures in the earth's crust are subject to continuous but slow change. Cycles of change are present and balances exist among crustal components and their environment.

38. The climate of the earth is affected by many factors including seasonal variations, latitude, ocean currents, topographical features, movements of air masses. Balances exist and cycles of change occur. There is a gradual change in climate due to certain changes in energy relationships.

39. The universe, of which earth is part, is an evolving body of matter and energy. Certain gradual, unidirectional changes are evident in stars and planets. Many changes occurring are cyclic.

40. Life on the earth is undergoing gradual but significant unidirectional evolutionary changes.

41. Man can use his understanding of his own functioning as an individual and as a group member, and the effect he and his technology have had on the natural environment to overcome present problems of pollution, over-population and depletion of natural resources. He can enjoy and make better use of natural resources and, at the same time, conserve them and the life dependent upon them.

SCIENTIFIC KNOWLEDGE

42. The following six themes have been changed to assist in deciding which ideas from the total sum of scientific knowledge should be included.

43. The six themes are important ideas in science. Other ideas may, in general, be accommodated within their framework.

1. The matter of the universe can be organized into units

44. The term 'unit' refers to any building blocks that can be organized into hierarchies. Thus at one time it may be appropriate to treat the cell as a unit of matter; at another, a single animal or part of the total population could constitute a unit.

11. Units can be organized into hierarchies

45. Units can be classified into levels of organization such that a number of units of any one level are combined to form a single unit at the next higher level. For example, certain atoms are combined to form a single unit, a molecule, at the next higher level. With few exceptions, a unit at any one level includes units from all lower levels as components and is itself a component of units at all higher levels.

46. A number of different hierarchies can be constructed, but all share the same lowest levels, for all matter consists of the same types of sub-microscopic units, namely, sub-atomic particles, atoms or ions, molecules. Above the sub-microscopic level, hierarchies differ according to the particular portion of the universe they describe.

47. There can be considerable diversity in structure and size among units at any one level of organization, for example, among molecules or among organisms.

111. The behaviour of units can be described and predicted

48. An important outcome of adequate scientific description and analysis is a capacity to make predictions. The analysis requires the use of models, mathematical and statistical methods, intuition and logical reasoning.

49. Statistical methods enable prediction of th...

planets. Many changes occurring are cyclic.

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48. An important outcome of adequate scientific description and analysis is a capacity to make predictions. The analysis requires the use of models, mathematical and statistical methods, intuition and logical reasoning.

49. Statistical methods enable prediction of the average behaviour of all units in a system, given the observed or deduced behaviour of a small but adequate sample. Statistical methods do not enable prediction of the behaviour or properties of individual units.

50. Description and prediction can proceed by the use of theoretical models. Although they cannot be proved, models such as the laws of thermodynamics and the theory of evolution are powerful in facilitating explanation and prediction as they have been found to be consistently valid.

IV. Motion is an essential part of most phenomena

51. Many phenomena may be described in terms of changes in properties or behaviour. These changes may be described as being consequences of motion of units of matter. For example, the whole field of current electricity can be explained in terms of the motion of charged particles.

V. Units interact within the dimensions of time and space

52. Interactions among and within units of matter may produce changes in form, properties or position. In the physical sense, this interaction can be described in terms of electro-magnetic, gravitational or nuclear forces (or fields), and can therefore be readily reduced to mathematical analysis. Units of living matter cannot be readily interpreted in like manner and it is more fruitful to study the behaviour of genetic material in terms of coded information and the energy transformation required to utilize this information in life processes.

53. The planets, natural satellites, starts, galaxies, and galactic systems are subject to transformations in substance, form, and position. These transformations involve exchange of matter and energy and the systematic motion of celestial bodies in a gravitational field of universal dimensions. Movements of the earth and moon serve as convenient bases for time units.

54. Materials of the earth undergo transformations. The rocks are products of changes in the form and organizations of the matter of which they are composed. In most instances, changes from one rock type to another also involve changes in volume, shape, and position of the material. The movement of molten rock material to the earth's surface and the transportation of sediment to the sea by rivers are familiar examples of changes in position. In contrast to the relatively slow geological changes, nuclear particles may undergo extremely rapid changes.

55. Several patterns of interaction are characteristic of living organisms:

55.1 Non-living matter becomes involved in processes and forms characteristic of living matter, but eventually returns to the non-living state. In a community, there is a cyclic transfer of matter between the various organisms and their physical environment.

55.2 The spatial distribution of individuals in a community results from interaction with the environment.

55.3 There are sequential patterns in the growth and fluctuation of populations.

55.4 There is an ecological succession of various communities in a newly formed habitat.

55.5 A great diversity of types of living organism has evolved over a very long period of time.

56. Other patterns of interaction in the natural world include:

56.1 The cyclic transfer of matter; for example, in the water cycle, convection cells, distribution of solar energy.

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56.2 Stellar evolution sequences in the birth and death of stars.

56.3 Sequences of geological events, as revealed by patterns in rock strata.

56.4 Successive stages in the evolution of landscapes characteristic of particular climates, rock and soil types.

56.5 The sequential development of soil types.

VI. Interactions between units tend toward a state of equilibrium

57. Man's experience has shown that two great principles apply without exception to every interaction. These two principles are embodied in the first and second laws of thermodynamics.

58. In the process of attaining equilibrium energy transformations and/or matter transformations occur. In most cases energy is conserved and matter is conserved. Where matter-energy transformations take place, the sum of energy plus matter is conserved. These conservations are embodied in the first law of thermodynamics.

59. The second law is concerned with changes in matter - the direction of these changes is such that greater randomness may occur in a system, but the reverse is not observed unless energy is supplied, i.e. complex molecules may disorganize into simpler components, but the reverse does not take place unless considerable free (or available) energy is available.

60. In living systems a relatively constant organization may be maintained, e.g. the charge on a cell membrane or the sugar level in the blood, but this requires the expenditure of energy with disorganization and death resulting if organism, or community, fails to utilize energy appropriately.

61. Homeostatic, or auto-regulating mechanisms, to ensure metabolic stability and energy balance are characteristics of living organisms.

62. The complex interactions of many different types of living organisms and their physical environment stabilize with the emergence of climax communities.

63. The input and output of energy from the earth as a planet is in balance, and results in patterns of atmospheric circulation.

64. All non-living systems tend towards either a minimum of potential energy or maximum randomness of molecular motion. The most disordered state has the greatest probability.

THE NATURE OF SCIENCE

65. In the following description of the nature of science it is not implied that the statements made apply to science as a unique study. The statements could be equally valid for other forms of human activity. It is appropriate to draw attention to certain aspects of science whether or not they are shared with other disciplines.

66. A study of the history of science is important as a means of gaining insight into the nature of science.

67. An awareness of the transformations engendered by science in man's thinking and beliefs in the past will help in developing an understanding of the impact of science and related technologies on past and contemporary society.

68. Science is a method of creating patterns out of the many things and happenings in the universe. The patterns are made by man and are his way of looking at nature. They represent the insight of the persons making them. Science is both the method of creating patterns and the patterns themselves.

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69. One of the main methods of creating patterns is the use of experimental inquiry to look for constancy, to look for events or characteristics of events, that repeat, always giving the same answer in the same circumstances. These constancies form a powerful tool for explanation and prediction, which can be verified by experiment.

70. The procedures of inquiry used by scientists follow no one clearly defined path. There are many procedures which can be followed in many different sequences but all of which lead to the extension of scientific knowledge.

71. The patterns include generalizations, general scientific ideas that act as cores of thinking, i.e. the laws of science which can be regarded as generalized records of observed facts of nature, and finally, there is a small number of big ideas which act as integrative bonds transcending subject boundaries. Conventions are adopted by scientists and are part of the patterns created.

72. Scientific knowledge consists of the patterns created by man. The essence of scientific knowledge is found in its conceptual framework, which is made up of the major patterns described by scientists.

73. The patterns (laws, conceptual schemes, conventions etc.) are not unquestionable of the truth, but change as scientific understanding improves or changes. There is no absolute knowable truth.

74. Some discoveries are the direct result of planned investigations and are frequently based on the work of teams of scientists from several subject areas.

75. Some patterns are conceived only through insight, and not by gradual step-by-step, planned investigations. Whenever new phenomena do not fix existing patterns (currently accepted theories) preconceptions can hinder and delay progress.

76. Sometimes science advances by the interaction of theory and technology, each providing information or techniques which can be used by the other.

77. Modern scientific research is costly and requires team work. Large sums have been allocated to such enterprises.

78. There are more people currently engaged in scientific research than ever before in the whole history of science. One direct result is the greatly increased output of published scientific literature.

USE OF THE ABOVE THREE AREAS OF CONSIDERATION

79. The environmental scheme is coherent, logical and consistent with Project aims. It is the main source of ideas for inclusion in the Project materials.

80. Ideas that arise from consideration of the environmental scheme are, for the most part, ideas concerned with scientific knowledge and/or the nature of science. Subsequent consideration of the latter two areas gives rise to further ideas, appropriate to the scheme outlined, and suitable for inclusion with the environment based ideas in a topic for classroom study.

81. The latter two areas are used occasionally as the prime basis for inclusion of ideas. In such a case, an idea is included from one of the two schemes, and the other two are considered for further ideas that may be joined with the basic idea to fit into a suitable topic for classroom study.

82. Some ideas are used as topic bases for reasons other than that they arise from the environment scheme, the six themes, or the nature of science as outlined. However, such instances are few in number.

83. When a topic has been nominated as suitable for development into a classroom unit, it and the ideas in it are judged according to a set of criteria. On the basis of these criteria, the topic is rejected or amended to meet the requirements. The procedures and criteria used are explained in detail in a separate paper.

Study Paper 2.

A SCHEME FOR THE INCORPORATION OF ENVIRONMENTAL STUDIES INTO THE SCHOOL CURRICULUM.

This scheme was developed by a study group of the International Working Meeting On Environmental Education In The School Curriculum convened by the International Union For Conservation of Nature and Natural Resources.

The working meeting was held as a part of the U.N.E.S.C.O.'s International Education Year in co-operation with U.N.E.S.C.O. and Foresta Institute at Foresta Institute for Ocean and Mountain Studies, Carson City, Nevada, U.S.A. during September 1970.

A. Purpose.

To formulate objectives in environmental education for the total curriculum.

B. Scope.

For purposes of organization the curriculum was divided into three stages:

Stage I	Primary	approximately ages 5 - 10
Stage II	Middle	approximately ages 11 - 14
Stage III	Secondary	approximately ages 14 - 17

The committee recognized that this organization will not exactly conform to current practices in many localities, but adaptations can readily be made. This particular plan reflects emerging interest in the middle school, and takes into account the research in educational psychology by Piaget, Bruner, Gagne and others.

The pre-primary stage was recognized as especially important in the educational pattern. The discussion revealed that this stage is not in existence in many localities. In view of this and the fact that time was limited, this stage was omitted from the deliberations.

At each stage, it is significant to keep in mind the sequential development of concepts, whereby understandings of one stage are built upon previous experiences. In addition to the vertical integration of the curriculum, it is important to plan horizontal integration in order to achieve a multi-disciplinary approach.

C. Major Focus of Each Stage.

Recognizing the developmental process in learning, a major focus was selected for each stage reflecting the over-all objectives of the program at the three levels as follows:

StageI -

Building basic vocabularies and skills leading to an appreciation and awareness of the varieties and similarities in the environment.

Stage II -

Emerging patterns and interrelationships of environmental features on local, national and world scales, concentrating on conservation and use. During this stage, particular attention is to be given to case studies illustrating representative man-environment problems.

Stage III -

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Stage III -

Increasing perception of changes through time with particular reference to in-depth studies of environmental and social problems; in short, developing an environmental ethic.

D. Content.

In order to give an indication of the content and objectives of an environmentally-oriented curriculum, a chart was prepared. It was agreed that while serving somewhat as a model for an interdisciplinary, developmental program in environmental education, the chart could be adapted to different national and local situations in a variety of ways.

The horizontal component of the chart is the three curricular stages indicated previously. The vertical component consists of the various major factors of the natural and cultural environment, rather than traditional subject headings.

The statements given under the headings at each level not only give an indication of content to be interwoven into instruction, but also suggests specific aims and objectives in furthering environmental education throughout the curriculum. The statements constitute performance objectives to be attained by students who have completed a stage in environmental education.

The chart as currently formulated reflects the limitations of time available at this international working meeting. It is recommended that further development and refinement of this work be an ongoing activity resulting from this meeting.

	SOCIAL ORGANIZATION	ECONOMICS	AESTHETICS,
STAGE I	Recognizes ways in which people organize themselves. Learns individual and group responsibility concerning environment.	Relates food, clothing and shelter needs to available resources. Finds that specialization of labor increase efficiency.	Builds a bas terms. Name animals, wat Acquires bas arts and mus environment
STAGE II	Observes the relationships between political and natural boundaries. Sees the state as an agency for working on environmental problems. Recognizes international co-operation as a means of solving environmental problems.	Observes patterns in organizing resources with an emphasis on their rational use. (Agriculture and grazing, forestry and fishing, mining and manufacturing, transportation and communication).	Uses visual language and interpret va how great ar their enviro
STAGE III	Acts to alleviate environmental problems through laws, public policy, and action programs.	Works toward domestic and international solutions of environmental problems related to nutrition, poverty, transportation, waste disposal, source and distribution of energy resources.	Has personal reflecting a environment to others.

...TION	ECONOMICS	AESTHETICS, ETHICS, LANGUAGE
... in which people ...lves. Learns ...group responsibility ...ronment.	Relates food, clothing and shelter needs to available resources. Finds that specialization of labor increase efficiency.	Builds a basic vocabulary of environmental terms. Names and classifies plants, animals, water features, soils, minerals. Acquires basic skills in using visual arts and music to express feeling for the environment in an elementary way.
...lationships between ...atural boundaries. ...s an agency for ...ronmental problems. ...national co-operation ...olving environmental	Observes patterns in organizing resources with an emphasis on their rational use. (Agriculture and grazing, forestry and fishing, mining and manufacturing, transportation and communication).	Uses visual art, music and dance drama, language and photography to describe and interpret various environments. Appreciates how great artists and writers have perceived their environments.
...te environmental ...h laws, public policy, ...rams.	Works toward domestic and international solutions of environmental problems related to nutrition, poverty, transportation, waste disposal, source and distribution of energy resources.	Has personal attitudes and habits reflecting a caretaker responsibility toward environment and communicates this feeling to others. Visual pollution.

STUDY PAPERS 3 and 4.

Both papers were written by members of the Secondary Science Committee. The papers were not intended to be learned expositions of Environmental Studies; their function was simply to present some ideas about Environmental Studies and to raise some questions.
Both papers should be read in this light.

Study Paper 3.

ENVIRONMENTAL STUDIES?

One hears so much about Environmental Studies at this present time. The media, particularly the press and television, devote very considerable amounts of space and time to it, student protest groups have espoused it, and tertiary education institutions, particularly in the United States, but also in other nations, have been prompted to develop schools for the study and teaching of it. Yet no one is clear as to what Environmental Studies is, let alone is able to delineate or define it.

We know certain things about Environmental Studies, but only in an imprecise fashion. We know, for instance, that Environmental Studies is concerned with pollution, conservation and that nebulous concept "the quality of life." We know also that it draws heavily on disciplines in the field of science for techniques, methodology and information, and on the field of philosophy for answers to moral, ethical and aesthetic questions. Further, Environmental Studies seems to concern itself with economics, psychology, politics, and sociology.

What other questions might we ask about Environmental Studies?

Is Environmental Studies a discipline or is it an agglomerate of elements brought together to deal with the problems of pollution and conservation? If Environmental Studies is an embryonic discipline it is most likely still in the data-gathering phase which most of the newer disciplines seem to have passed through. Disciplines like Ecology and Molecular Biology have passed through this "stamp collecting" phase and other disciplines like Psychology, Sociology and perhaps Geography are passing through into a second "interpretive" phase in which a network of interrelated, explanatory laws and theories develop to interpret the previously collected data. In this phase disciplines seem to become characterized by their own particular, but not unique, methodologies. Environmental Studies, if an embryonic discipline, would be expected to follow a pattern reasonably similar to that of Ecology, a discipline which it resembles, and develop, in time, its own methodology and substantive structure. If Environmental Studies is not a discipline it will not develop its own methodology and substantives and will remain, at best, an interdisciplinary approach to certain problems, drawing on the disciplines as it needs on order to provide solutions to problems.

What elements are present in Environmental Studies that are present in other disciplines or fields? We have noted above that Environmental Studies draws heavily on other disciplines. Sciences like Biology, Physics and Chemistry contribute heavily in that they provide both quantitative data, and the methodology for obtaining quantitative data, which at the moment seems to b[illegible]

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What elements are present in Environmental Studies that are present in other disciplines or fields? We have noted above that Environmental Studies draws heavily on other disciplines. Sciences like Biology, Physics and Chemistry contribute heavily in that they provide both quantitative data, and the methodology for obtaining quantitative data, which at the moment seems to be concerned only with the biosphere. The behavioural sciences contribute both quantitative data and methodology and a deal of theory. So, too, do disciplines like economics, politics, geography and the histories. But Environmental Studies does not seem to stop there. It seems to want to make decisions, value judgements, about the data it obtains and thus the disciplines of ethics, morals and aesthetics are drawn upon. This integrative phenomenon may be illustrated by many examples -- a pertinent one for us is the conservation of the Kangaroo. It would seem that a decision has already been taken by many people that Kangaroos should be conserved. In the future, judgements of this nature will probably have to be "justified", which, of course, is where the philosophies will be drawn upon. Having taken the decision to conserve the Kangaroo a large number of aspects of the problem are now being attacked by drawing upon the various scientific disciplines and economics. In this particular case it is interesting to note that psychology and political science are being brought to bear along with practical politics.

Does Environmental Studies possess a set of clearly defined characteristics of its own? Obviously this is a matter of opinion as we have no criterion of "clearly defined", but it would appear from the preceding discussion that some characteristics stand out. At this point in time Environmental Studies is clearly integrative, using materials from as many disciplines as it needs and attempting to put them togetjer to make a whole. It is also clear that Environmental Studies is concerned with the total biosphere, and in this context it is possible to see a dichotomy arising. Some may see Environmental Studies as a "maxi-ecology", concerned with the interrelationships of the total biosphere, others may see it as a "mini-ecology" concerned only with the interrelationships of the biosphere which impinge on man. Whichever way, it is clear that Environmental Studies is concerned with many more factors than is ecology. It would seem that it is concerned with both describing and making value judgements about the natural world.

Is Environmental Studies concerned with fundamentals of the natural world and not just problems crucial at this ti e? This question is very difficult to answer. It is clear to even the most casual observer that Environmental Studies is concerned with the problems of conservation and pollution, and it may be that these problems are in fact manifestations of more fundamental problems - as yet we do not have sufficient evidence to decide. It is probably true to say that man is now in the position where he must begin to make decisions regarding the future of the biosphere and form of the biosphere in the future. If the investigation of these decisions becomes the role of Environmental Studies and Environmental Studies attempts to develop a knowledge framework in which to make these decisions then it would appear that Environmental Studies is concerned with fundamentals in our world.

What must we do to teach Environmental Studies? From the preceding discussions it can be seen that Environmental Studies, at the moment, is composed mainly of knowledge and methodologies derived from a wide range of disciplines. Any attempt to teach Environmental Studies should reflect this multidisciplinary approach - a very difficult problem for the greater majority of teachers who are usually reasonably specialist in a restricted number of disciplines. One solution to this problem is the effective use of team-teaching. In this way a number of teachers from various disciplines can co-ordinate their activities so that childrens' learning experiences can reflect a multidisciplinary approach. A second problem concerns the pupils' state of knowledge. As yet Environmental Studies does not have its own methodology or substantives but relies on various disciplines. This would seem to suggest that the best training for Environmental Studies is to be found in existing disciplines (but more than are taught as subjects in schools.) Science has a particular stake in this, simply because it supplies the basic methodologies for data gathering and manipulation in most situations. Thus Science teaching can probably contribute best to Environmental Studies by teaching children how to be scientific, when to be scientific, and when not to be scientific.

Teachers in this day and age find themselves under considerable pressures, some of them self-generated. One particular pressure is for education that is appropriate to the present state of society, and many people would maintain that Environmental Studies is appropriate. Perhaps these people are hasty in their judgement, for if Environmental Studies is just a particular agglomerate brought together to solve certain problems it is bound to change as problems change, and perhaps disappear altogether. Nevertheless science teachers can contribute to Environmental Studies and to the Science education of students at the same time. (This may not always be the case, if and when Environmental Studies develops its own methodology and substantives the study of science will become less relevant to it. By adopting appropriate learning experiences (remembering that students exhibit very little transfer of training) that teach children how to be scientific, when to be scientific and when not to be scientific, the ends of an appropriate general education may be served.

Study Paper 4.

ENVIRONMENTAL STUDIES

To attempt to define Environmental Studies would be futile; the study of our environment is without boundaries. But the emphasis on its study is a new trend in education.

The traditional school curriculum is composed of separate subjects studied mainly because they have been studied in the past. This has produced teachers with some acquaintance with the subject, and so they are able to perpetuate them in the schools. So we have French and Geography, British History and Chemistry because we have people to teach them.

Let us take a fresh look at the curriculum. Three main areas can be identified:

First, the school teaches practical skills - how to cook and sew, how to work wood, how to type and balance ledgers, how to spell, speak and construct sentences.

Second we try to develop the student's aesthetic appreciations - of music, art and literature, foreign languages, and perhaps, enjoyment of physical exercise.

Third, we introduce students to some areas of human knowledge, and to various ways of looking at the world, through the disciplines of the sciences, mathematics, history, geography and economics.

It is the third areas, it seems to me, which is most difficult to justify. Why should students learn about energy conservation, quadratic equations, the Tudors and the Stuarts, or Indian agriculture? The traditional answers are not convincing and it is here that the concept of environmental studies suggests a rationale, and a new relevance, for the school curriculum.

During the last decade, there has been an upsurge of concern about what human beings are doing to the earth. We realise that the planet's resources are finite, and must be managed rather than exploited, maintained rather than exhausted. This is a challenging and urgent task which demands great knowledge and skill. It is a universal problem, and one which will always be with us. It requires co-operation between governments and private enterprise, ecologists and economists, engineers and artists, sociologists and chemists. This synthesis of the various fields of human endeavour is essential if we are to turn the Earth into the type of place in which we want to live. The human race has developed technologies to provide material needs, to annihilate distance, to diminish disease. But accompanying these has been crowding, noise, emotional tension, pollution, ugliness, and the destruction of much of the natural world. We know more and more clearly what alternatives the use of technology offers us, but we must decide which of these we wish to accept. We must clarify our values and state our priorities.

In the secondary schools, we must sensitise students to the importance of this synthesis; when they leave school, people should have some idea of the way in which the various disciplines contribute to the solution of our immediate social problems, and what prospects they offer for shaping the type of future we want.

The investigations that the student teachers should be undertaking are those into the various aspects of their complex environment: THE PRODUCTION OF FOOD AND CONSUMER GOODS, BUILDING MATERIALS, HOUSING, TRANSPORT, COMMUNICATION, DATA PROCESSING, GOVERNMENT, THE LAW, SOCIAL INSTITUTIONS, COMMUNITY HEALTH, RECREATION, ENTERTAINMENT, THE ARTS.
The various disciplines can all contribute to an understanding of our present environment, and of the possibilities for the future. I suggest that the traditional subjects are justified in the curriculum only to the extent to which they contribute to this understanding.

If we accept this role for the school - to encourage students to investigate aspects of their world, and to see the interrelationship between them, then there are several consequences for the curriculum:

1. It seems impossible for the individual teacher to handle such an approach. A team of teachers, each with expertise in some relevant field of knowledge, must contribute to the program of study for students.

2. Each school, each group of students, will have a different background experience, a different immediate environment from which to start their investigations, and so they will each have a different curriculum.

3. As most of the topics are complex, small groups of students would each work on different parts of the topic, and report back to a larger group.

4. There must be much more contact between the schools and the community which it serves. The answer to most of the interesting problems the student will encounter are <u>not</u> given in textbooks. Teachers and students should use the school as a resource centre, and as a place to work, but also as a base from which they will move out to study aspects of the human and natural communities nearby.

5. The school must have a very large resource centre to which students have ready access; and students must also be given opportunity and encouragement to use other libraries and information services in the community.

6. The main role of the teacher will be as a consultant and organiser. There is very little scope for him as a dispenser of information. Students will raise problems which the teacher cannot answer, and should not try to; but he can suggest possible approaches, and references to help them.

7. There must be much more use of group discussion techniques. Ultimately, all of the important topics involve the formation by students and teachers of personal values. These values must be based on as much evidence as can be collected, but they will be <u>formed</u> mainly through dialogue with others.

8. Above all, the students should be encouraged to study in such a way that they will continue to investigate and be interested in their environment when they no longer have the school to help them.

To do this, the emphasis must be on topics which the students find interesting and relevant. Most of the work should be initiated by the students who will at times work as autonomous, self-motivated individuals, while at other times they can co-operate with others in a group investigation.

How does science fit into such a scheme? Its two important contributions to an investigation are KNOWLEDGE and METHODOLOGY.

<u>KNOWLEDGE</u>

In many areas, informed and intelligent decisions cannot be made by people ignorant of some of the scientific principles involved. Emotional statements about conservation or pollution or health are not worth consideration unless the person making the statement has some factual and conceptual basis for them. There is the need to develop scientific literacy - that is, an understanding of perhaps 30 or 50 fundamental terms of wide applicability in data gathering. (We have a list at ASEP).

A case can be made for teaching some of these bits of knowledge <u>before</u> students will use them in investigations. Formal teaching of the concept of energy, basic chemistry, cell physiology, ecology and other topics could prepare the students for an investigation of a nearby river system. But these teaching sequences could be, in most cases, fairly short. And we now have a definite purpose in teaching them. Some of the topics could, no doubt, be taught at the student's request.

METHODOLOGY

On the other hand, scientific ways of tackling problems are probably best learned "on the job" that is, in actual investigations. Students should be encouraged, whenever they wish to obtain reliable results, to ask, "How do you know?"; to demand evidence for statements, to check with other sources, to measure, to compare, to use controls, to generalise, and to frame hypotheses which could be disproved. The teacher with a science background can act as a "devil's advocate" in student investigations.

Records were kept by group leaders of the discussions which took place in each of the groups. These have been summarised and put together under headings for ease of reproduction. Where basically similar points have appeared more than once a composite comment has been made.

COMMENTS.

Concerning School Organization:

1. Considerable difficulty will be experienced in implementing environmental studies programmes because of inflexibility of school organization. This difficulty should not be seen as sufficient reason for absence of environmental approaches. If environmental approaches are absent it should be for educational reasons.

2. Effective environmental approaches will require development of new techniques in areas such as;

timetabling,
utilisation of teaching space,
approach to design of teaching space,
and teaching procedures.

3. Although a number of schools appear to be working with environmental programmes communication of ideas, experience and criticism between schools is very difficult. This communication needs to be facilitated.

Concerning Curriculum Organization.

1. Environmental Studies should not be seen as just "ecology/conservation/pollution". It should be seen as a study of the whole environment in which pupils are living, and will continue to live as adults.

2. Concern was expressed that mathematics could be neglected in an environmental programme because of its apparent lack of relevance.

3. An effort should be made to relate aspects of all disciplines to the understanding of the environment.

4. Two approaches to environmental teaching are possible;
(a) free investigation by pupils followed by utilisation by the teacher of whatever comes out.

(b) a set plan of work to be accomplished which will allow students to draw predetermined conclusions.

There would seem to be no criteria for choosing between these two other than "whichever will achieve the programme objectives best".

Concerning Teaching ...

measure, to compare, to use controls, to [illegible]

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There would seem to be no criteria for choosing between these two other than "whichever will achieve the programme objectives best".

Concerning Teaching Approaches.

1. Environmental examples could be incorporated into current courses, but could prove to be superficial if care was not exercised.

2. It was agreed that topics could not last more than about a month for any groups up to and including middle ability level Form IV.

3. It was agreed that it is important to avoid repetition of topics to the point that pupils became bored. Although it was felt that repetition can help build up concepts, it was also felt that the disadvantages of boredom outweighed the advantages of sophisticated concepts.

4. Preference was expressed for the use of a "reference library" of smaller books, rather than a textbook, in the teaching of Environmental Studies.

One group brought up a particularly important point concerning the motivation of students in environmental programmes. They expressed the feeling that more information should be sought concerning whether environmental programmes provided greater motivation than traditional approaches.

A Four-Year Science Course With Environmental Bias.

Preamble.

This scheme can be added to or subtracted from at will: at the moment it simply represents a set of ideas capable of development, depending on the area and the teacher. Teachers who feel that the scheme would not adequately prepare students for fifth form science subjects may easily modify it to meet their needs. Preferably this could be done by dropping some topics and enlarging others to incorporate the content they would like to see there.

Form I.

Theme: The Local Environment.
Survey and mapping of the local area.
Land use. e.g. Factories, gardens, housing, farms. This could be preceded by the JSSP unit "Looking For Patterns" - the need for classification.
Land forms and the way they have arisen. Consequences of land forms and land use related to land forms.
The effects of industry on the local environment.
Interesting or important forms not in the strictly local environment.
The soil.

Form II.

Theme: Housing - The Child's Home Environment.
Survey of houses in several different areas within the local Municipality or several areas in Metropolitan Melbourne. This study should lead to the reasons for different houses being built in different areas and to investigation of a wide variety of construction methods and materials.
The strength of materials.
The advantages and disadvantages of various construction materials. This section has many practical possibilities.
The time line used by builders to regulate the work of tradesmen.
Flooring and foundations. Relate to Land forms, soils, availability of materials, soil, water, elementary surveying, etc..
Heating. (JSSP unit on heat could be used here)
Lighting. Elementary experiments with light.
Power sources - oil, gas, electricity, coal etc.
Insulation. This should ideally be considered with heating.
Electricity - switches, fuses, simple circuits.
Household waste disposal. Destruction, reclamation and other utilization.
The environmental effects of waste disposal.
Metals in the home.
Climate as a factor of the local environment.

Form III.

... They expressed the feeling that more information should be sought concerning whether environmental programmes provided greater motivation than traditional approaches.

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Electricity - switches, fuses, simple circuits.
Household waste disposal. Destruction, reclamation and other utilization.
The environmental effects of waste disposal.
Metals in the home.
Climate as a factor of the local environment.

Form III.

Theme: The Community.
(i) Recreation Areas.
Survey of local parks, gardens, sports arenas to investigate types of vegetation and the effects of altering land forms by levelling and filling.
The distribution of wildlife and national parks in Victoria Geological forms and ecological systems. (JSSP unit "Things and Places" could be used here.)
Beaches as ecological units. Seasonal sand shifts and silting of bay and beach areas could be considered here.
(ii) Communication.
Methods of communication. Aspects of sound and magnetism. (The JSSP unit on sound and part of the JSSP "Force and Interaction" could be used.)
Noise and neon signs could be considered as forms of pollution arising from communication.

Elementary radio. Mainly signal detection - perhaps the construction of crystal sets.
Forms of transportation. Noise and chemical pollution.
Vehicular traffic and traffic surveys.
Navigation and surveying required by transportation systems, including astronomy.
(iii) Industry.
Energy sources.
Industrial processes in the local area and the technology associated with it.
Products and by-products which effect the environment.

Form IV.

Theme: The Needs Of Man.
Air: Its composition, its use, its use in the body and its contaminants.
Water: Its composition, its use, its use in the body, its contaminants and its purification.
The water cycle.
Systems concerned with water use.
Water use in space travel.
Food. Cropping and land use with particular reference to land forms.
Food manufacture, including preservatives and packaging.
Agricultural sprays and fertilizers.
Microbes. (Secondary Science Committee unit on Microbes could be used here.)
One or more projects in the environment. These projects would be selected in such a fashion that they would draw upon the skills and abilities developed in earlier topics. (Ideas may be obtained from texts like "Discovery in Science".)

A List of Suggested Ideas Which Could Be Used as Projects or Teaching Units.

These ideas could be used either as part of a science programme or as part of a general environmental programme.

1. The effect of fertilizers on worm populations in soils.
2. Whether the growth of herbs and some other plants can help in the control of insect pests.
3. Biodegradability of detergents.
4. Optimum temperature for the operation of ensymes in washing materials.
5. The nature and effects of food preservatives.
6. Erosion.
7. Humidity measures in different climates.
8. Land utilization survey of a local community.
9. The microclimates of tall buildings.
10. The destinations of waste materials in the home.
11. The effects of converting natural water courses to drains etc.
12. The establishment of a conservation programme in the school yard.
13. Studying the changes in a region by historical methods.
14. Traffic surveying inside school buildings..
15. Temperature in rooms as a function of characteristics of the room.
16. The relationship of topography to community type.
17. Noise problems within a school.
18. The effect of type of surface on water runoff.
19. The investigation of blowfly breeding under controlled conditions.
20. The effects of a new school on the local habitat.
21. A soil profile map of a limited area.
22. The effect of sunlight and other variables on algal growth in rainwater tanks.

APPENDICES.

I. MILLIPORE APPARATUS.

The microbiological activities in this conference were carried out using Millipore apparatus. One complete session of the conference was devoted to demonstration of the uses of this equipment.

We would like to thank H.B. Selby and Co. and Mr. Colin Marshall of that establishment for their help and cooperation in the provision of apparatus for our conference.

People who wish further information regarding Millipore apparatus should contact

Mr. Colin Marshall,
H.B. Selby and Co., P/L/.
352 Ferntree Gully Rd.,
Notting Hill, 3168.

II. RESULTS OF THE CLASSROOM ACTIVITIES SESSION

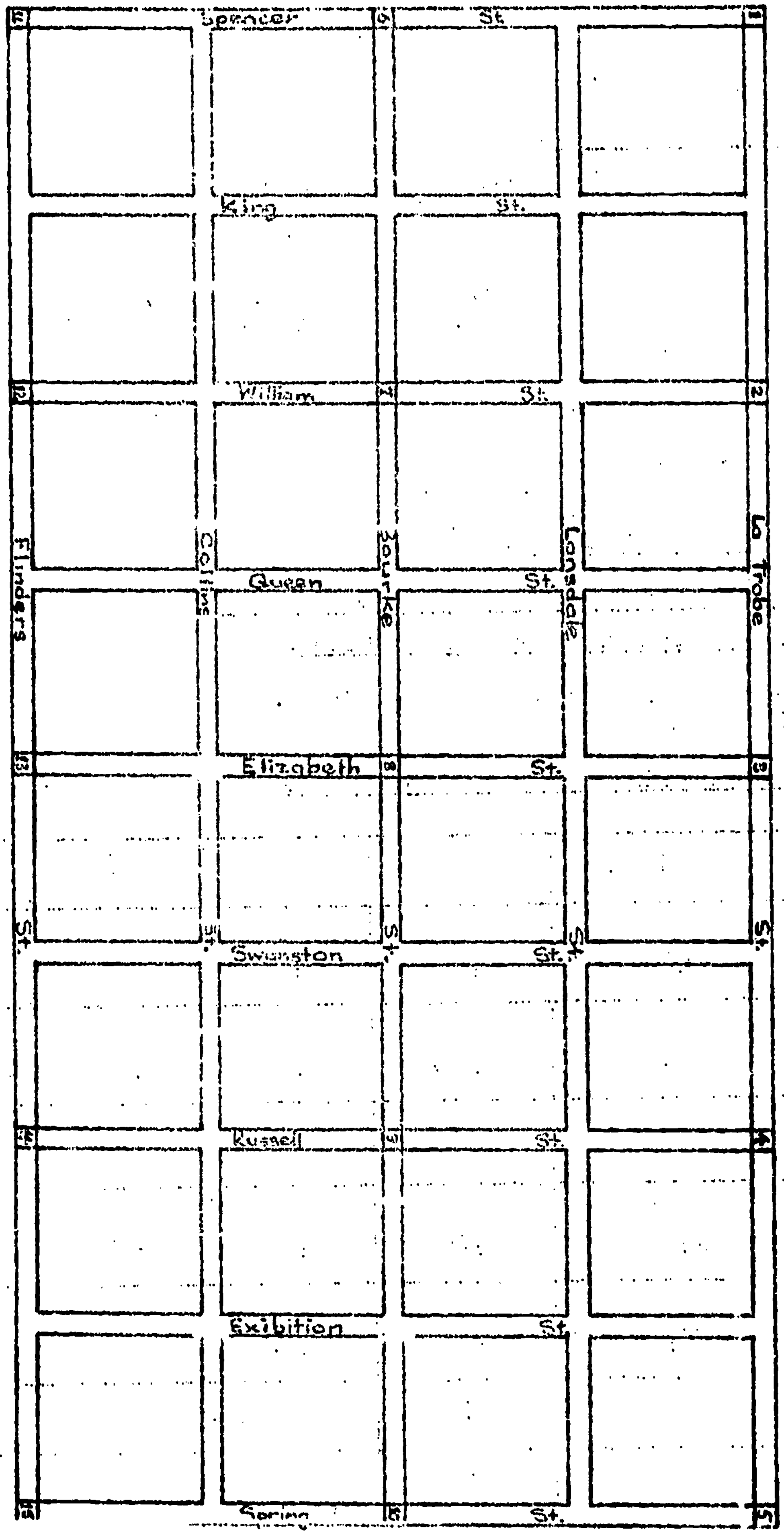
1. Measurement of Atmospheric Solids.

Below are the results of this activity. The key to the sites is on the following page.

Average Particle Count Per Field of View (X100 magnification)

SITE	1	2	3	4	5
Agar Plate	26 (3,85)	20 (6,43)	13 (3,32)	9 (6,26)	19 (6,48)
Plain Plate	12 (6,16)	23 (3,49)	24 (5,58)	44 (9,150)	61 (41,104)
SITE	6	7	8	9	10
Agar Plate	21 (6,53)	26 (4,87)	15 (8,41)	20 (6,41)	11 (8,26)
Plain Plate	56 (11,216)	15 (2,34)	20 (1,47)	11 (2,30)	8 (5,10)
SITE	11	12	13	14	15
Agar Plate	17 (12,32)	14 (3,25)	26 (15,64)	10 (4,16)	23 (6,47)
Plain Plate	12 (8,19)	19 (5,34)	24 (18,30)	32 (1,125)	28 (4,59)

Note. The figures in brackets are the lowest and highest values recorded at any one site.



Spencer St.
King St.
William St.
Queen St.
Elizabeth St.
Swanston St.
Russell St.
Exibition St.
Spring St.
Flinders St.
Collins St.
Bourke St.
Lonsdale St.
La Trobe St.

2. Estimation of the Carrying Capacity of a Roadway.

(a) Traffic Count, Tullamarine Freeway, 15/2/'71.

Period (5 mins.) Beginning. (am.)	Number of Cars.	Mean Time for Transit. (570 ft.) (secs.)
8.30	215	7.3
8.35	170	7.7
8.40	175	7.7
8.45	175	7.6
8.50	110	7.5
9.00	90	8.4
9.05	70	8.3
9.10	75	7.6
9.15	86	7.2
9.20	105	7.8
9.25	106	8.1
9.35	77	7.9
9.40	85	7.7

(b) Traffic Count, Johnson Street, 16/2/'71.

Period (5 mins.) Beginning. (am.)	Number of Cars.	Mean Time for Transit. (570 ft.) (secs.)
8.30	340	40.2
8.35	360	83.2
8.40	304	51.5
8.45	303	27.7
8.50	369	20.9
8.55	268	18.1
9.00	232	10.1
9.05	192	11.5
9.10	198	11.0
9.15	178	11.2

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9.00	232	10.1
9.05	192	11.5
9.10	198	11.0
9.15	178	11.2
9.20	123	11.3
9.25	120	10.8
9.30	134	11.5
9.35	138	11.0
9.40	117	10.0

3. Observation: Errors and Measurement.

No results are appended for this activity because the objective of the tasks was to elicit mistakes. Instead the task sheets have been included to indicate the sort of things done.

BENHAM DISC. (See last page of this Appendix.)

A circular disc is rotating at high speed.
The speed of rotation will be reduced by stages.
Describe the colour of the disc at each stage.

1. ....

2. ....

3. ....

4. ....

Disc at rest. ....

MEMORY.

A number of familiar objects will be on view for a short period of time.

List the objects

....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

Total number of objects. ....

ESTIMATION.

(a) Estimate the weight of the labelled match boxes.

A. ..... B. ..... C. ..... D. ..... E. .....

(b) Estimate the volume of liquid in the labelled test tubes.

A. ..... B. ..... C. ..... D. ..... E.. .....

(c) Estimate the length of the labelled pieces of wood.

A. ..... B. ..... C. ..... D. ..... E. .....

(d) Estimate the angles made by the blue wool and the red wool.

Red angle .... Blue angle ....

(e) A transparency of geometrical shapes will be displayed for a measured, short period of time.

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List the objects

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....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

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A. ..... B. ..... C. ..... D. ..... E. .....

(d) Estimate the angles made by the blue wool and the red wool.

Red angle .... Blue angle ....

(e) A transparency of geometrical shapes will be displayed for a measured, short period of time.

Slide 1. How many shapes are on this slide? ....

Slide 2. How many stars are there in the second slide? ....

Slide 3. How many triangles are there in the third slide? ....

(f) How many times have the demonstrators left and re-entered the room since the session started? ....

(g) Estimate the duration of the exposure of the third slide.

....

IDENTIFICATION.

(a) Identify the liquid in bottle A by odour. ....

(b) Now identify the substances in bottles B to E.

B. .... C. .... D. .... E. ....

4. & 5. Water Analysis.

(a) Freshwater. Samples taken from River Yarra

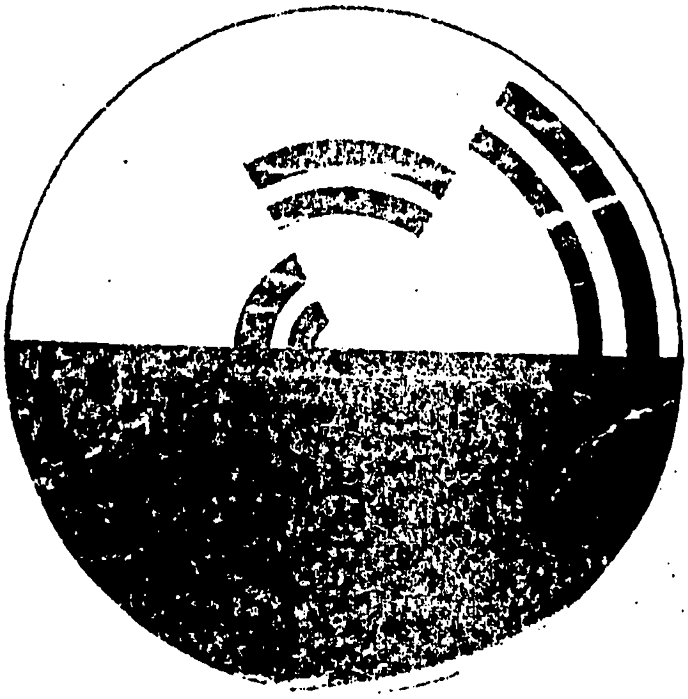
Location	"Chloride" Concentration. mg./1.				"coliform" colonies per 100 ml. sample				pH
Replication	1	2	3	MEAN	1	2	3	MEAN	
Williamstown Ferry	7350	8010	7920	7760	0	1	0	1	-
Old Olympic Pool	1450	1420	1420	1430	0	1	0	1	6
Scotchburn Street	89	71	107	89	0	0	0	0	5/6
Dight's Falls	77	71	107	85	0	0	0	0	6
Fitzsimmon's Lane	20	356	45	139	3	33	11	16	5
Warrandyte	18	36	27	27	110	43	30	61	5.5
Yarra Glen	18	36	36	30	58	0	2	20	5.5
Healesville	18	54	77	48	188	0	0	63	5.5
Tap water Secondary T.C.	9	77	27	41	17	2	21	13	4.8

For comparison purposes a sample of seawater from Aspendale was analysed. The "chloride" content of this sample was found to be approximately 18,000mg./1.

(b) <u>Seawater</u>. Samples taken from Port Phillip Bay.

Location	Carbon dioxide Concentration p.p.m.				"coliform" colonies per 100 ml. sample				pH
REPLICATION	1	2	3	MEAN	1	2	3	MEAN	
Blairgowrie	13.6	30	4	16	0	2	0	1	7
Dromana-Safety Beach	24	25	25	25	0	0	0	0	6.5
Mornington	15	22	11	16	0	0	8	3	6.5
Frankston-Seaford	39	12	16	26	0	13	0	4	6.5
Mordialloc Jetty	12.4	11.5	59	28	0	0	1	.3	7
Sandringham Marina	36.3	4	23	21	0	0	0	0	7
Elwood	23	5	42	23	45	0	1	15	7
Ferguson's Pier	27	18	28	24	0	3	3	2	7
Williamstown Main Beach	32.9	4	25.1	21	0	1	0	.3	7

THE BENHAM DISC



NOTE In manufacturing the disc the diameter should be increased to approximately twice that illustrated.

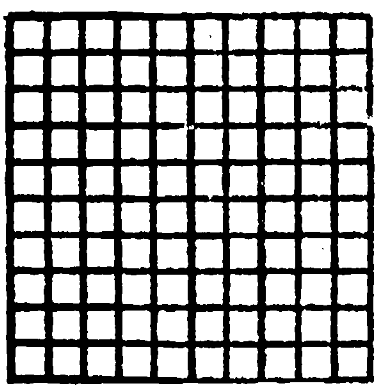
Best results will be obtained if the black and white of the pattern are perceived as being visually dense.

SMOKE HAZE DENSITY CARDS.

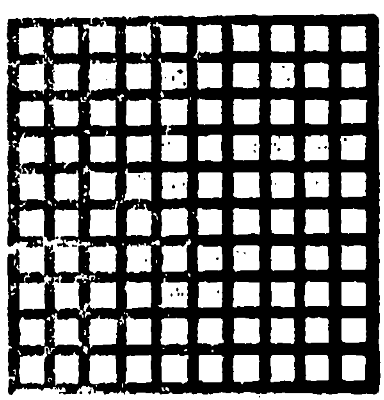
WITHIN LIMITS, CARDS MAY BE ANY SIZE.

Percentage black on the cards: 1. 20%. 2. 40% 3. 60% 4. 80%.

1

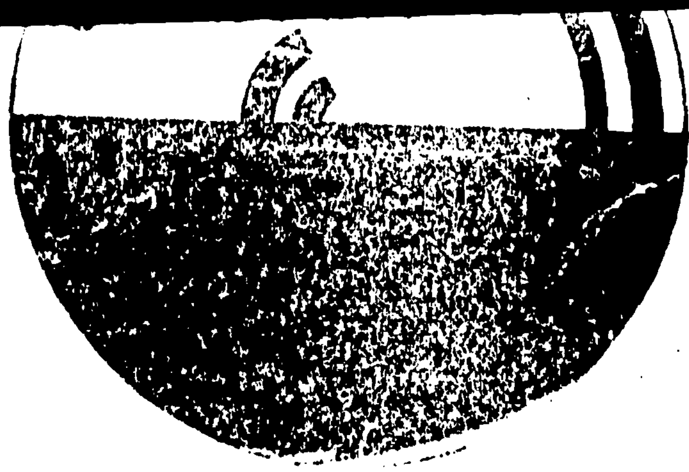


2



3

4



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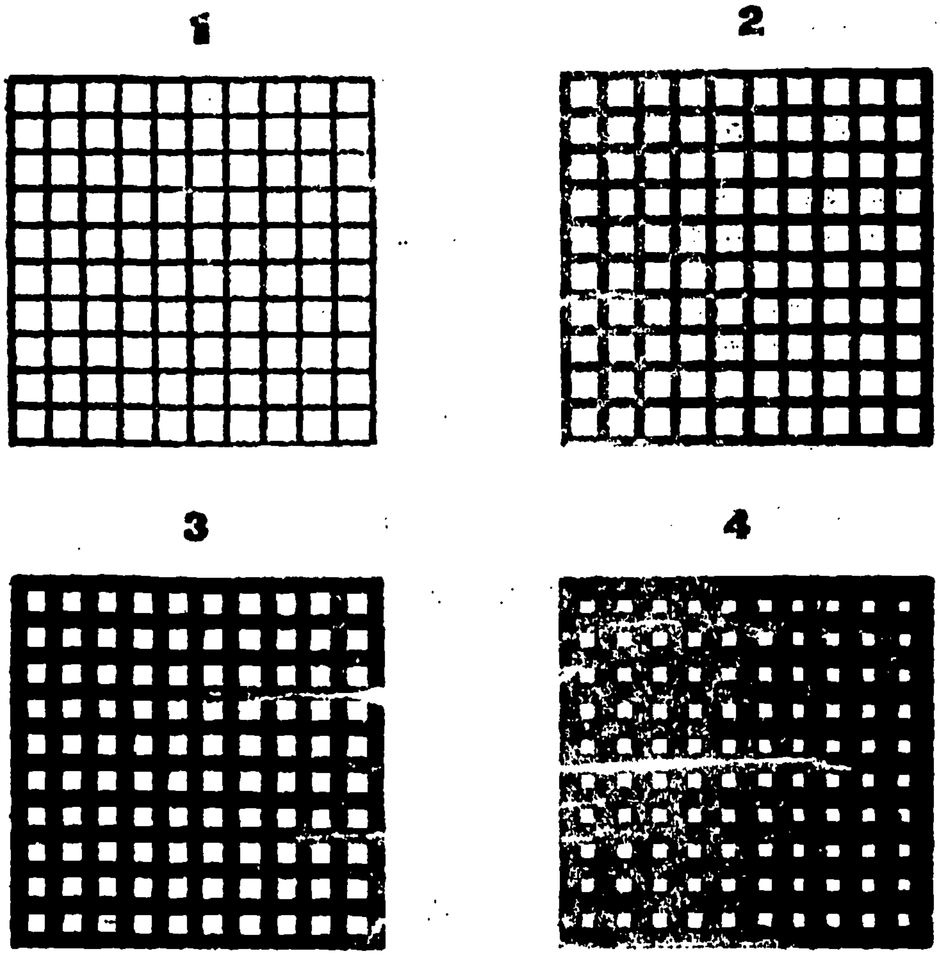

III. EVALUATION QUESTIONAIRE

The last session of the conference was concluded by participants filling out a simple questionaire about the conference itself. The questionaire was comprised of questions and biased statements which participants were asked to express an opinion about. As a matter of interest this questionaire has been included in the proceedings.

The figures in the boxes indicate the number of participants making that particular response to the statement. The brackets after the questions contain the responses made to the question.

This seminar is part of an experiment in the development and dissemination of new ideas in the field of Science Curriculum. The organisers of the seminar are dependent on reliable feedback from participants for the evaluation of both the seminar and the idea investigated. To this end your objectivity and candor in filling out this questionaire will be greatly appreciated.

Below are a number of statements, each of which is followed by a series of five boxes. Place a tick in:

Box 2 if you strongly agree with the statement.

Box 1 if you agree with the statement.

Box 0 if you have no opinion about the statement.

Box -1 if you disagree with the statement.

Box -2 if you strongly disagree with the statement.

The questions have been grouped together for ease of analysis.

Statement	2	1	0	-1	-2
1. The lectures were interesting as a whole.	14	38	3	9	0
2. The lectures provided worthwhile information.	7	42	7	7	1
3. The lectures provided you with ideas worth thinking about.	24	32	5	0	0
4. Some changes should have been made to the lectures.	6	18	23	11	2

What changes would have made?

(1. A more detailed programme of the content of the two days should have been prepared and sent to schools prior to the conference.

2. More lecture time should have been given to the practical teaching situation in this field.

3. Some more detailed lectures about the practical situation in this field should have been included.

4. A course of study should have been developed and studied in lectures.)

Statement	2	1	0	-1	-2
5. The lectures should have been left out of the programme.	0	3	5	16	35

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4. A course of study should have been developed and studied in lectures.)

	Statement	2	1	0	-1	-2
5.	The lectures should have been left out of the programme.	0	3	5	16	35
1.	Discussions in the seminar sessions raised important questions.	16	29	6	8	41
2.	Discussions in the seminar sessions allowed interchange of ideas between participants.	24	31	1	5	1
3.	The seminar sessions allowed sufficient time for discussion.	8	28	5	15	8

4. The seminar sessions were too closely structured.	4	5	15	26	12
5. Some seminar sessions should have been allowed for participants to discuss whatever they liked.	7	19	12	15	8
6. Printed materials used in the seminar sessions were sufficient in quantity.	11	35	8	10	0
7. Printed materials used in the seminar sessions were sufficiently informative.	8	26	14	13	2
8. Changes should have been made to the discussion sessions.	4	8	22	20	2

What changes would you have made?

(No responses were made to this question.)

9. The sessions on practical work did not help participants.	10	16	8	19	14
10. The sessions on practical work could have been made more useful if certain changes had been made.	12	15	13	16	6

What changes would you have made?

(No responses were made to this question.)

11. The proceedings of the seminar sessions were not worth reporting.	5	8	9	21	15
12. The seminar sessions were of little use.	3	10	9	26	15
1. A conference on this topic was unnecessary.	1	5	3	18	36
2. This sort of conference was not the best way of covering this topic.	4	9	15	16	13

3. What changes should be made to the format of this conference?

(1. More initial planning should have been carried out.

2. More definite instruction on teaching should have been included.

3. The conference should have been longer and included more detail.

4. The conference should have included surveys of the ...

5. Some seminar sessions should have been allowed for participants to discuss whatever they liked.

7	19	12	15	8

6. Printed materials used in the seminar sessions were sufficient in quantity.

11	35	8	10	0

7. Printed materials used in the seminar sessions were sufficiently informative.

8	26	14	13	2

8. Changes should have been made to the discussion sessions.

4	8	22	20	2

What changes would you have made?

(No responses were made to this question.)

9. The sessions on practical work did not help participants.

10	16	8	19	14

10. The sessions on practical work could have been made more useful if certain changes had been made.

12	15	13	16	6

What changes would you have made?

(No responses were made to this question.)

11. The proceedings of the seminar sessions were not worth reporting.

5	8	9	21	15

12. The seminar sessions were of little use.

3	10	9	26	15

1. A conference on this topic was unnecessary.

1	5	3	18	36

2. This sort of conference was not the best way of covering this topic.

4	9	15	16	13

3. What changes should be made to the format of this conference?

(1. More initial planning should have been carried out.

2. More definite instruction on teaching should have been included.

3. The conference should have been longer and included more detail.

4. The conference should have included surveys of the work being done in this field in this state.

4. What topics do you feel should be covered by teachers' conferences?

....

(1. Science materials.

2. Physical problems of science teaching.

3. Timetables and science teaching

4. Class size and science teaching.

5. Specific methods of science teaching.)

....

5. What sorts of conferences do you feel these topics require? (Please indicate above)

....

6. What topics do you feel should be covered by conferences like this one? ....

(No responses were made to this question.)

7. This sort of conference is not a good way to help teachers.

2	3	4	26	19

It has been suggested that the proceedings of this conference be collated together and distributed.

1. The proceedings of the conference should be collated

27	20	3	1	3

2. Who should receive copies of the proceedings?

(No responses were made to this question.)