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ABSTRACT

Included are two sections contributing to understanding of the model: (1) Orientation; and (2) Content Specifications. The model is intended to provide the user with a frame of reference within which to formulate and plan environmental education and training products which: (1) develop grade K-9 natural science teachers' understanding of environmental education; and (2) develop their professional capabilities in devising instructional/learning arrangements which communicate a similar understanding to their students. (Author/RE)

THE NATURAL SCIENCE ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL

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THE NATURAL SCIENCE ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL

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by

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This document is one of a series of Teacher Training Models for Environmental Education. The titles of the individually available documents in this series are:

THE HIGH SCHOOL ENERGY/ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL
Orientation
Content Specifications
Curriculum Management Specifications
Implementation Model

COMMUNITY LEADERSHIP ENERGY/ENVIRONMENTAL EDUCATION MODEL
Orientation
Content Specifications
Implementation

THE SOCIAL SCIENCE ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL
Orientation
Content Specifications

THE NATURAL SCIENCE ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL
Orientation
Content Specifications

THE ENVIRONMENTAL EDUCATION SOURCEBOOK

Far West Laboratory would like to acknowledge the contribution of the Institute for Advanced Systems Studies, California State Polytechnic University at Pomona for the development of portions of the above materials. We would also like to acknowledge the contribution of the following consultants: George Michael Black, Richard D. Britz, Ronald G. Klietsch, Daniel Litowsky-Ducasa, Jr., and David B. Sutton.

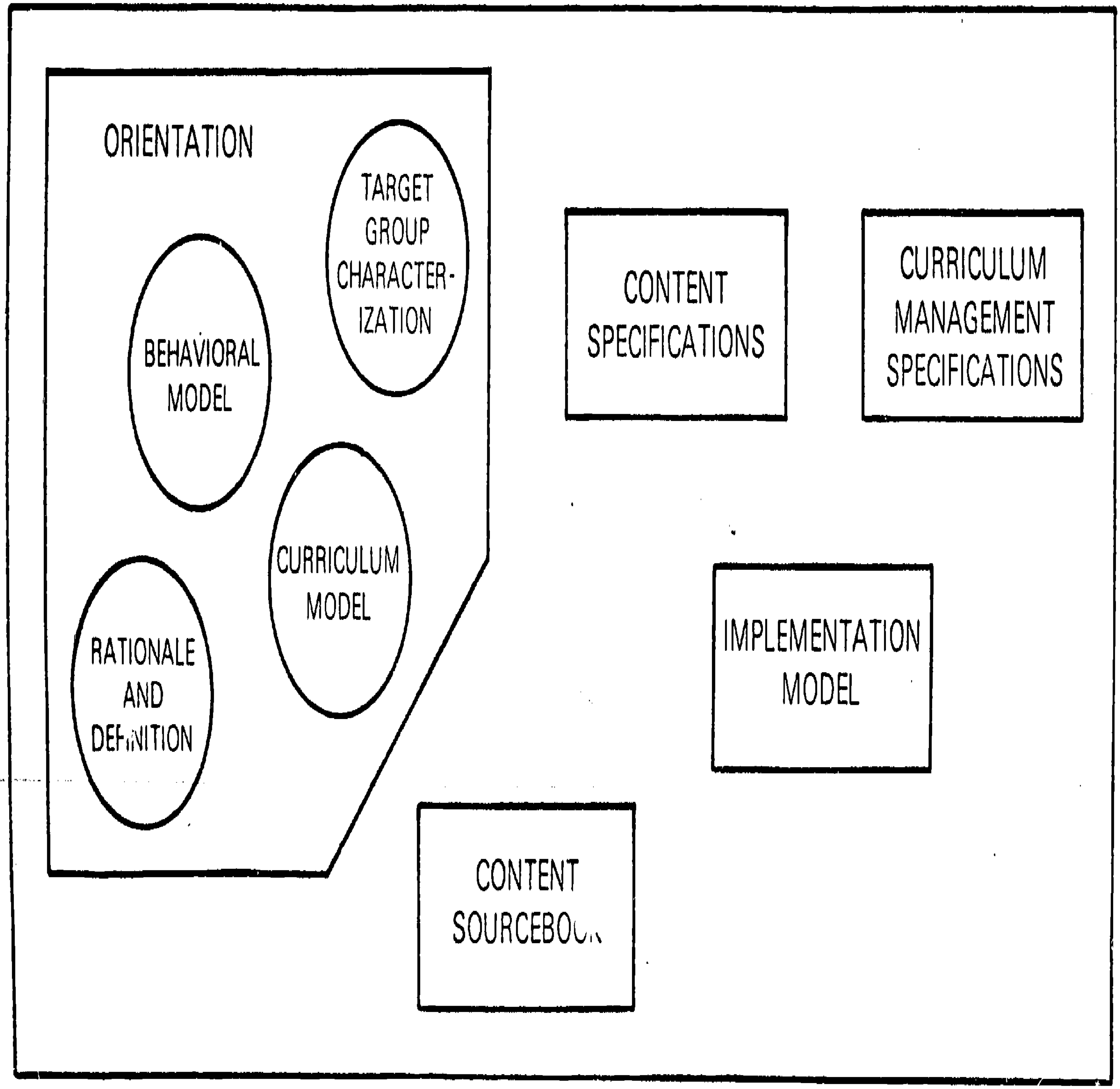
PREFACE

The Natural Science Environmental Education Teacher Training Model is presented in the following documents:

- Orientation Guide
- Content Specifications
- Curriculum Management Specifications (not completed as part of this contract)
- Implementation Model (not completed as part of this contract)
- Content Sourcebook*

These documents represent an attempt to characterize and integrate the systems complex of environmental education (EE) and teacher training. They are intended as orienting documents for curriculum or program developers. Accordingly, it is hoped that this Model will provide the user with a conceptual map or frame of reference within which to formulate and plan environmental education programs and training products which (1) develop grade K-9 Natural Science teacher's understanding of EE, and (2) develop their professional capabilities in devising instructional/learning arrangements which communicate a similar understanding to their students.

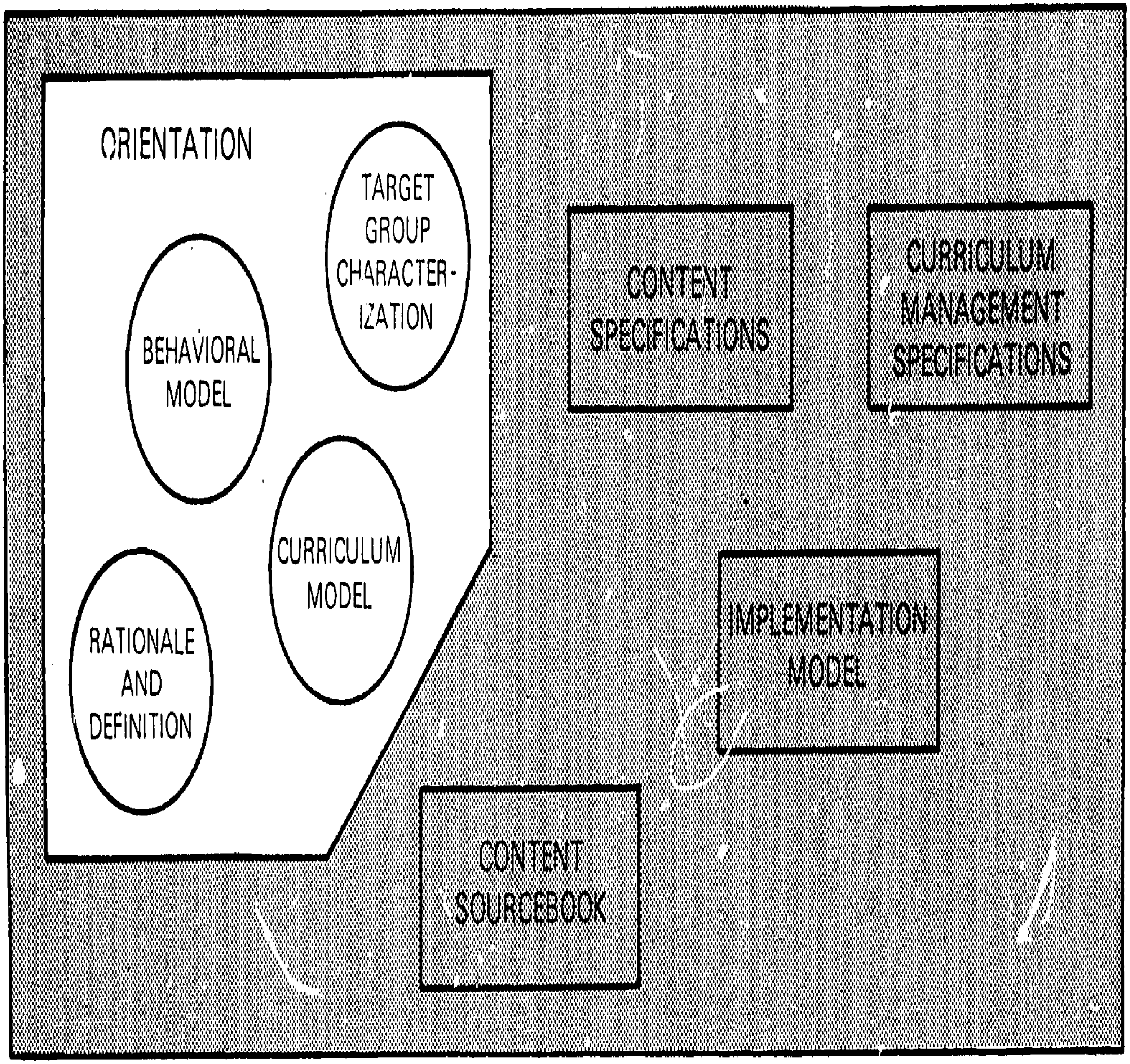
* The Content Sourcebook will be available as a separate publication.



ENVIRONMENTAL EDUCATION
TEACHER TRAINING MODEL

Orientation

THE NATURAL SCIENCE ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL



ENVIRONMENTAL EDUCATION
TEACHER TRAINING MODEL

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INTRODUCTION

> We have not yet learned, of course, to balance all our environmental objectives against the other social goals that must concern us. But it is now clear that the American people believe our needs for food, for shelter, and for the necessities as well as the amenities of civilization can be met without continuing the degradation of our planet. It is clear that they wish, as Congress stated in the National Environmental Policy Act, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.
>
> President Carter's message in transmittal of the Eighth Annual Report of the Council on Environmental Quality

While the <u>idea</u> of environmental education is well known, widely supported and the subject of much discussion internationally, nationally, regionally and locally, its <u>implications</u> and <u>characteristics</u> have been somewhat elusive and, until recently, less than clearly understood. The debate on the characteristics and implications of environmental education was initiated in policy terms upon introduction of the education bill that was to become the Environmental Education Act. The debate centered on the need for the Act and specifically on the question of what the Act might contribute to the "idea" of environmental education that was not being addressed by existing activities and programs. The results of that debate are reflected in the language and reports on Public Law 91-516 and its amendment, PL 93-278, the Environmental Education Act.

The implications and characteristics identified and hence the substance of the Act were derived from the most comprehensive and

cogent perceptions of the problems to be addressed on the one hand and the prerequisites and potential capability of general education on the other.

In brief, the Act in its original and amended form emphasizes:

1. A concept of environment which includes man, his activities, values and perceptions (the total human environment) as well as the biological/physical.

2. The interrelatedness of "systems" aspects of environment, environmental problems, and environmental impact.

3. The need for policies concerned with long-range or future consequences as well as immediate impacts of plans and activities on environmental quality.

4. The need to consider psycho-social, economic, cultural and other subjective (man-centered or perceived) factors in addressing physical environment problems. (The only substantive change introduced by the 1974 amendment to the Act was the explicit inclusion of economic consideration.)

5. The need for informal public participation in the support of policies and programs (decision/actions) concerned with environmental quality.

6. The need for new educational approaches capable of dealing with holistic problems in holistic contexts.

Given the above, and equally important, the experience to date in environmental decision-making indicates that:

- environmental <u>problems</u> might more accurately be characterized as environmental <u>issues</u>;

- <u>resolution</u> would be a more appropriate objective than <u>solution</u> since the term "solution" assumes a far greater <u>level of</u> consensus and knowledge (scientific and non-scientific) than is the case;

- more informed and rational consideration of the relationships between mutual and respective impacts of environmental, economic and social concerns is required;

- informed, broader-based public dialogue is necessary to elicit the appropriate <u>questions</u> and thus better statements of the issues.

While the challenge inherent in these requirements is both intellectually and operationally enormous, it is being addressed in increasingly meaningful ways by a number of governmental and private entities. These requirements, the knowledge base that is evolving to meet them, and the constraints and opportunities for its application/adaptation in a wide range of educational contexts are the basis of the environmental education program strategy.

The evolving knowledge base addresses problems of content, context and processes/methodologies for technical treatment of content/context. The areas of commonality between the approaches and/or outcomes of efforts such as those cited below can be summarized as follows. They are concerned with the identification, articulation, and portrayal of:

- opportunities and constraints in multidimensional ways, taking into account social, natural and psychological (values) factors;
- relationships between dimensions rather than focusing on each as a separate and unrelated factor, as is traditional;
- a range of choices for possible action rather than insisting on a single best solution or reducing choice to a minimum;
- opportunities and constraints in an interactive, futures-oriented context--e.g. in a manner that portrays what is now known without prejudicing the use of what might be learned in the future.

As suggested above, development of the knowledge base requires not only in depth knowledge of the well-defined components of the knowledge base (disciplines, subject fields) and of the parameters/characteristics of the ill-defined components (e.g. values), but also the ability to appropriately select, organize, and apply these

knowledge components in creative new ways, to create a synthesis of knowledge areas appropriate to the needs, to generate or identify questions from which new knowledge can be generated.

Finally, and specifically because no single discipline, subject field, or information source is adequate for characterizing, understanding or informing the problem area(s), both the content/context and process/methodological development thrusts are dependent upon continuing interactions/co-learning among broad networds or environmental information sources for purposes of assuring appropriate consideration of all principal "reality" factors (well-defined and ill-defined) and hence elucidating more clearly the parameters for decision-making. Education is deemed to be the most, if not only, appropriate "institution" for meeting the educational needs related to environmental quality since it embraces directly or indirectly most of the critical philosophical and practical concerns of the nation, in both current and futures contexts.

These premises are based on the belief that education continues to be the primary vehicle for meeting needs in a democratic society; and that education is a continual process through which the individual should acquire sufficient knowledge, decision-making/problem-solving skills and motivation to responsibly participate in the planning and management of a democratic society and its concerns. More specifically, there was and continues to be a rather widespread concern that the clearly evident public interest in environmental quality matters become more informed, less superficial or over-simplified in perspective and approach.

The long-term and complex requirements for meaningful improvement in and maintenance of environmental quality necessitate the development among citizens of a functional understanding of these requirements as well as motivation and skills for responsible, informed participation in environmental planning and decision-making. Short-term, generalized, or adversary public information campaigns are not adequate to meet either the short or long-term needs.

The Environmental Education Act mandates the support of a range of developmental activities as needed to create the resources required to meet these educational needs. It was recognized in enactment of the legislation that such resources were not in existence, nor at that point in time could they even be defined beyond the general requirements embodied in the law and suggested in the findings of the Congress. It was noted, however, that development of resources appropriate to the need would require the synthesis of current knowledge, traditional disciplines or subject fields.

One of the objectives of the Environmental Education program, therefore, is to develop and deliver Environmental Education resources that are responsive both to the knowledge base as it evolves and target group needs and "readiness" over time. The basic activities entailed in this objective are the continuing assessment and analysis of developmental needs and resources vis a vis content requirements; development of conceptual and generic models; and assistance in development and implementation of programs (learning designs) derived from the models.

PART ONE
A SYSTEMIC APPROACH TO ENVIRONMENTAL EDUCATION

The approach of the Environmental Education Act of 1970 is based on the philosophy that all persons be given the information they need to develop a broader perception of their self-interest. It does not sanction an attempt to change the attitudes or values of the population, but rather to provide "models of instruction" that will clarify and make visible values, issues, and alternatives.

> There should be available [to program developers] a variety of tested, relevant, and useable models that they can use or adapt to provide structure, process and substance.[1]

Both the Office of Environmental Education RFP 75-31 and the Arizona State University Report specify that a general systems approach can serve as an organizing vehicle about which a holistic and transdisciplinary model could be designed.[2,3] "Holistic models" and "systems approach" are nearly synonomous in that they both deal with components and the interactions among components. The nature of the interactions varies from subtle "influences" which are difficult to detect, to actual physical "couplings" familiar in the study of physical models. "Models of instruction" are "soft" models in that the nature of the major interactions of their components are "influential" as opposed to physical.

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[1] Federal Register, Vol. 39, No. 99, May 21, 1974, Sec. 3.2 (a).

[2] RFP 75-31, U. S. Office of Education, Office of Environmental Education.

[3] Arizona State University Center for Environmental Studies and Association of American Geographers, Environment-based Environmental Education: Inventory, Analysis, and Recommendations, June, 1975.

A "holistic" model of instruction has an entire range of possible interaction characteristics from influences (soft connections) to actual physical couplings (hard connections) such as limited physical classroom arrangements and inflexible hierarchies of authority and policy. A holistic model of instruction includes these components: content modules, instructional resources, implementation strategies, and curriculum management methods.

It is important to mention here the hierarchical nature of the language of holistic, transdisciplinary models. Models are abstract constructions of reality and can be regarded as a "map" of the territory. The language used to describe the map of the territory is different from that used to describe the territory. The language of the model (or map) is, by necessity, more abstract and abbreviated than the language of the whole reality (or territory). If this were not the case, models would not be more convenient to use than the reality itself. So, the requirement for model languages to be more abstract and abbreviated than the language of reality forces them to be more general, to avoid getting lost in the detail of reality; and to be more abstract, to avoid getting tangled in the narrowness of specific concepts about reality. Thus, by necessity, the language of the model must be at least one level higher hierarchically than the reality it is attempting to describe.

In the specific case of EE, an effective multidisciplinary, systemic and holistic educational model must be constructed in a holistic, generally systemic and transdisciplinary language. From the definition of this need, and through the efforts of the Office of Environmental Education such a language is emerging.

A model of instruction that is based on a general systems approach can display well the many interactions that exist within our natural environment:

- Interactions within the total <u>human system</u> (social, economic, technological)
- Interactions within the total <u>natural system</u> (physical, biological, ecological)
- Interactions between these two systems

The following discussions expand on the nature of each of these interactions.

A. HUMAN SYSTEM INTERACTIONS

Interactions within the total human system can be represented very generally by the classifications of "ekistics," a body of thought originated by the Greek planner Constantinos Doxiadis which addresses the whole of humanity's culturation process.[4] Ekistics observes the cultural/urbanization process from an anthropocentric point of view. It regards the institutions of society as aggregates of individual decisionmakers, and as such, they are responsible for the interactions among five major areas of society.

The Environmental Education Act (PL 91-516 as amended) also identifies the major areas of society that are the concern of EE: population dynamics; pollution; resource allocation and depletion; conservation; transportation; technology; urban and rural planning; environmental quality and ecological balance. In addition, three more entities have been added: natural resource related careers and vocations, economic and technological development, and environmental ethics. These areas are called the Key Environmental Entities in the Environmental Education Teacher Training Models and are correlated with the ekistics model in the following diagram.

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[4] Doxiadis, Constantinos, Ekistics, An Introduction to the Science of Human Settlements, New York: Oxford University Press, 1968

	KEY ENVIRONMENTAL ENTITIES	EKISTIC VIEW	EKISTIC SYSTEM MODEL
TECHNO SYSTEMS	Pollution Resource Allocation Technology Transportation Urban and Rural Planning	SHELTERS Housing Community facilities NETWORKS Public utility systems Transportation systems Communication systems	
HUMAN SYSTEMS	Population (dynamics) Natural Resource related Careers and Vocations Environmental Ethics Economic Development	THE INDIVIDUAL Physiological needs Safety and security Affection Knowledge and esthetics SOCIETY Public administration and the law Social relations Population trends Cultural patterns Economic development	
NATURAL SYSTEMS	Resource Conservation Resource Depletion Environmental Quality Ecological Balance	NATURE Climate, water, soil Plants, animals Geology, topography Resources, land use	

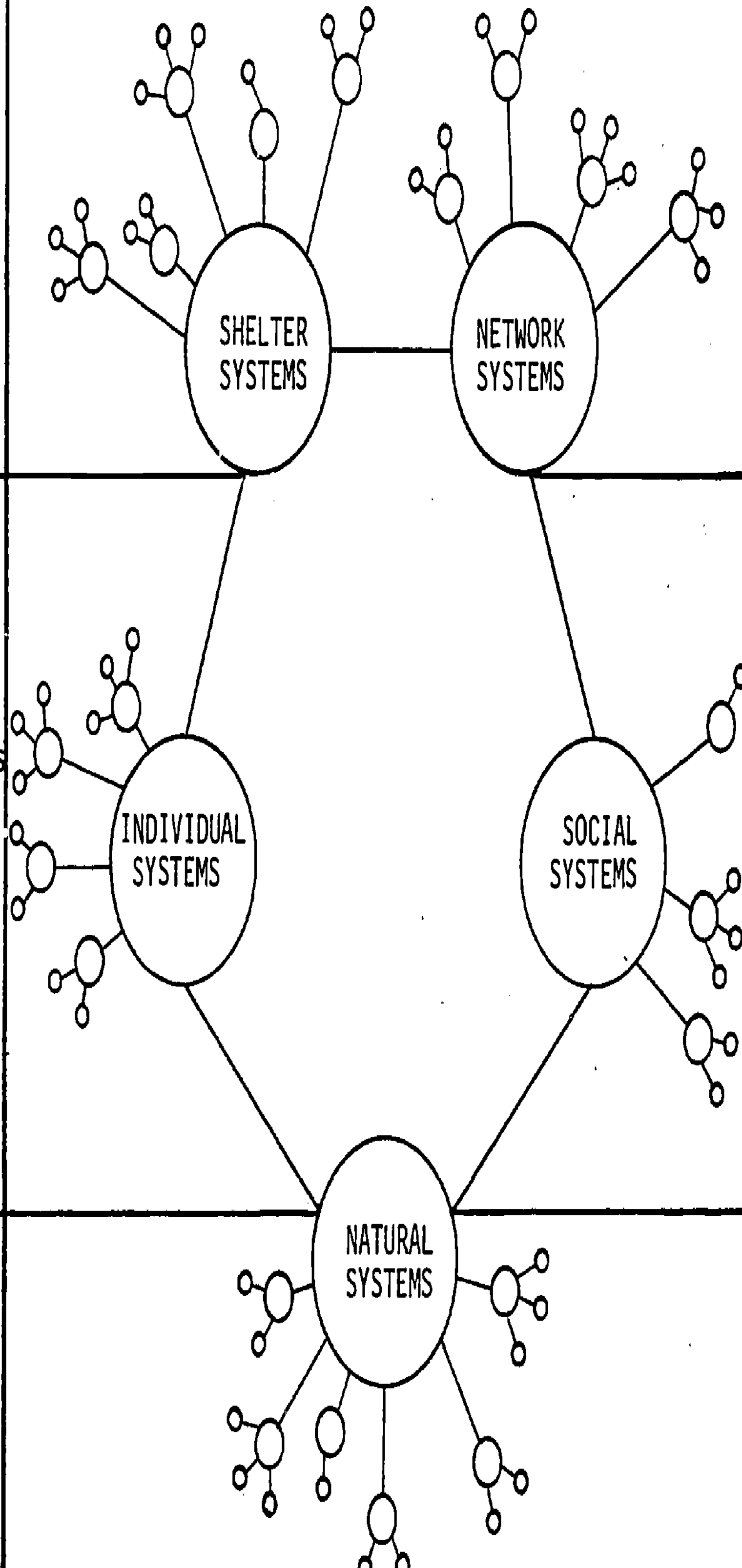

FIGURE 1. Relationship of the Key Environmental Entities to the Ekistic System Model

In order to be manageable, the classifications are very general, and therefore, readily debatable. The essential point is, however, that according to ekistics, society is responsible for the management of all societal sectors. The dynamic nature of these interactions cannot be shown by ekistics models which tend to be node-link diagrams identifying proximal relationships between specific aspects of components.

The dynamics of interactions within the human system can be understood, however, by studying the results of computer simulations of models developed by Jay Forrester and his colleagues of the Systems Dynamics Group at MIT.[5,6,7,8] The graphical outputs illustrate the effects of interactions in the human sectors as portrayed by mathematical equations. These models cannot be manipulated without a sophisticated knowledge of mathematics and computer technology; in their graphical diagrammatic form they lend little to the intuitive understanding of the reality they portray.

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[5]Forrester, Jay, Urban Dynamics, Cambridge, Mass.: MIT Press, 1969.

[6]Forrester, Jay, World Dynamics, Cambridge, Mass.: Wright-Allen Press, Inc., 1973

[7]Meadows, Dennis et al, Limits to Growth, New York: Signet Books, 1972.

[8]Mesarovic, Mihajlo, and Pestel, Eduard, Mankind at the Turning Point, New York: E. P. Dutton & Co., Inc., 1974.

B. NATURAL SYSTEM INTERACTIONS

Interactions with the total natural system can be shown by several methods of graphic display. The most holistic system of graphical diagramming is presented within the context of energetics, developed primarily by Howard T. Odum.[9] Energetics follows the laws and constraints of physical science and insists that all flows of energy be accounted for. Every piece of material, information or money interacting in the real world has an energy aspect and the movement of these substances requires further expenditures of energy.

Originating in the "hard" sciences related to the holistic field of systems ecology, energetics is continually developing explanations of cultural events that include "soft" sciences like economics and planning.

Utilizing a set of simple symbols for stages of energy flow and storage, complex systems can be graphically depicted as the following diagram illustrates:

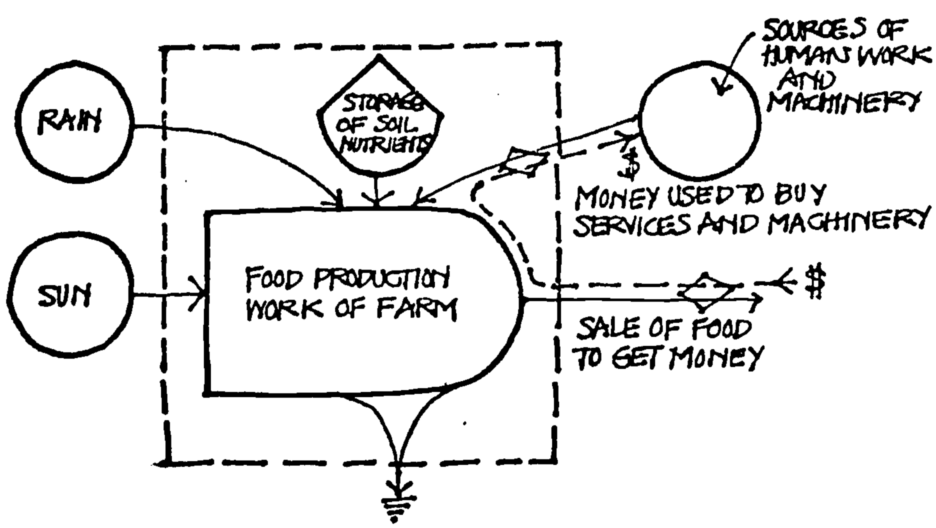


Fig. 2. A Farm System

[9] Odum, Howard T., Environmental Power and Society, New York: Wiley Interscience, 1968.

C. HUMAN AND NATURAL SYSTEM INTERACTIONS

Interactions between the total systems of humans and nature are obviously very complex and unwieldy to imagine, let alone to attempt to portray. This task is the main thrust of developing environmental education models of instruction.

Two factual realities are present with respect to these systems:

- Man belongs to both the human system and the natural system.
- The human system is contained physically and temporarily within the natural system

This arrangement is an example of the concept of nested systems: one system (humanity) is contained within another system (nature). Until recently, these nested systems manifested no important conflicts or contradictions. Individual humans and the human system survived and developed, sustained by the natural system often referred to as the bio-life support system.

During the present century, however, the expansion of the human system in size, complexity, and especially in energy consumption has brought about impacts on the natural system that have resulted in system dysfunctions in both the human and natural systems.

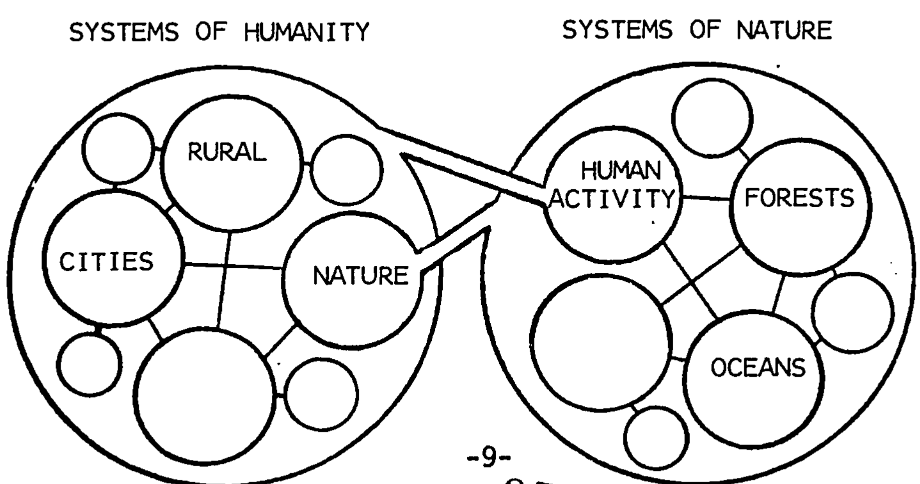
Almost ten years after the Earth Day activities of the late sixties, three "truths" have emerged after considerable cultural introspection by the most powerful and power-consuming nation on earth:

1. Humanity's physical health is dependent upon the health of the whole environment
2. Humanity is responsible for the condition of its environment
3. Humanity is polluting its environment

It has become apparent that behavior patterns such as unrestricted growth, failure to establish restorative cycles, mismatches of human and natural systems energy levels and rhythms--all of which have become standard operating procedure for survival and success in the human system--were damaging to the whole natural system of the biosphere. Apparently, the nested system of humanity is in conflict with its host system, the context of the natural system.

The systems approach of environmental education searches for the original cleavage in a "core belief" or in a set of primary value constructs that facilitates the cascading experiences of events that eventually generate conflicts in human/nature relationships. Understanding this set of values is essential for initiating a re-integration of the teacher/educator and his or her relationship to the holistic fabric of environmental education.

As previously mentioned, the language of model making must be of a higher hierarchical order than the reality being modeled. In this case, the model being developed represents the wedding of two holistic points of view. The perceptual field of interactions seen by both the <u>total human system</u> and the <u>total natural system</u> appear to each to be complete. Each "field" contains the other "field" as a component within its own jurisdiction. The following diagram illustrates this:



With the two systems joined in this manner, they form a synergistic suprasystem from the point of view of holistic environmental education. Rather than seek a solution to an apparent paradoxical confrontation between mutually co-defined bodies of thought, environmental education occupies a third mediating position with this suprasystem. This strategy will develop a position of balance and literally enable environmental education to mediate or facilitate a mutually agreeable re-solution by defining the apparent paradox within a holistic, transdisciplinary body of thought. The language and theory of general systems can provide a basis for understanding these interactions between the systems of humans and nature.

A model of instruction for EE must also have an educational domain which presents the requirement for a systems education point of view to be contained within the mediative EE "field." Such a model currently exists in a well-developed form and is readily adaptable to the additional requirements of environmental education.[10] The field of systems education has been consistently developed for several years utilizing a systems approach. It draws heavily from concepts in the traditional "hard" sciences like cybernetics as well as the "soft" sciences of psycho-sociology and organizational development.

Clearly, two holistic comprehensive channels of thought are joined in the development of a "model of instruction" for environmental education: a channel devoted to the substance or content of EE, and

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[10]Banathy, Bela, Developing A Systems View of Education: The Systems-Model Approach, Belmont, California: Fearon Publishers, 1973.

a channel devoted to the instruction/learning methodology of EE. These two channels of thought are analogous--like in form or pattern--and homologous--like in origin.

Designing an Environmental Education Teacher Training Model (EETTM) based on our understanding of the principles on which human and natural systems operate and interact dictactes that the model be open-ended and readily revisable, since our understanding is incomplete and always changing. It must be an adaptive model, building in a corrective way on the experiences accrued in its application.

Further, because of the comprehensive and holistic nature of the subject matter, it is not readily subsumed into any one specialized discipline, and therefore, the EE model must be integrative--a useful framework for showing the environmental relationships disciplines have with one another.

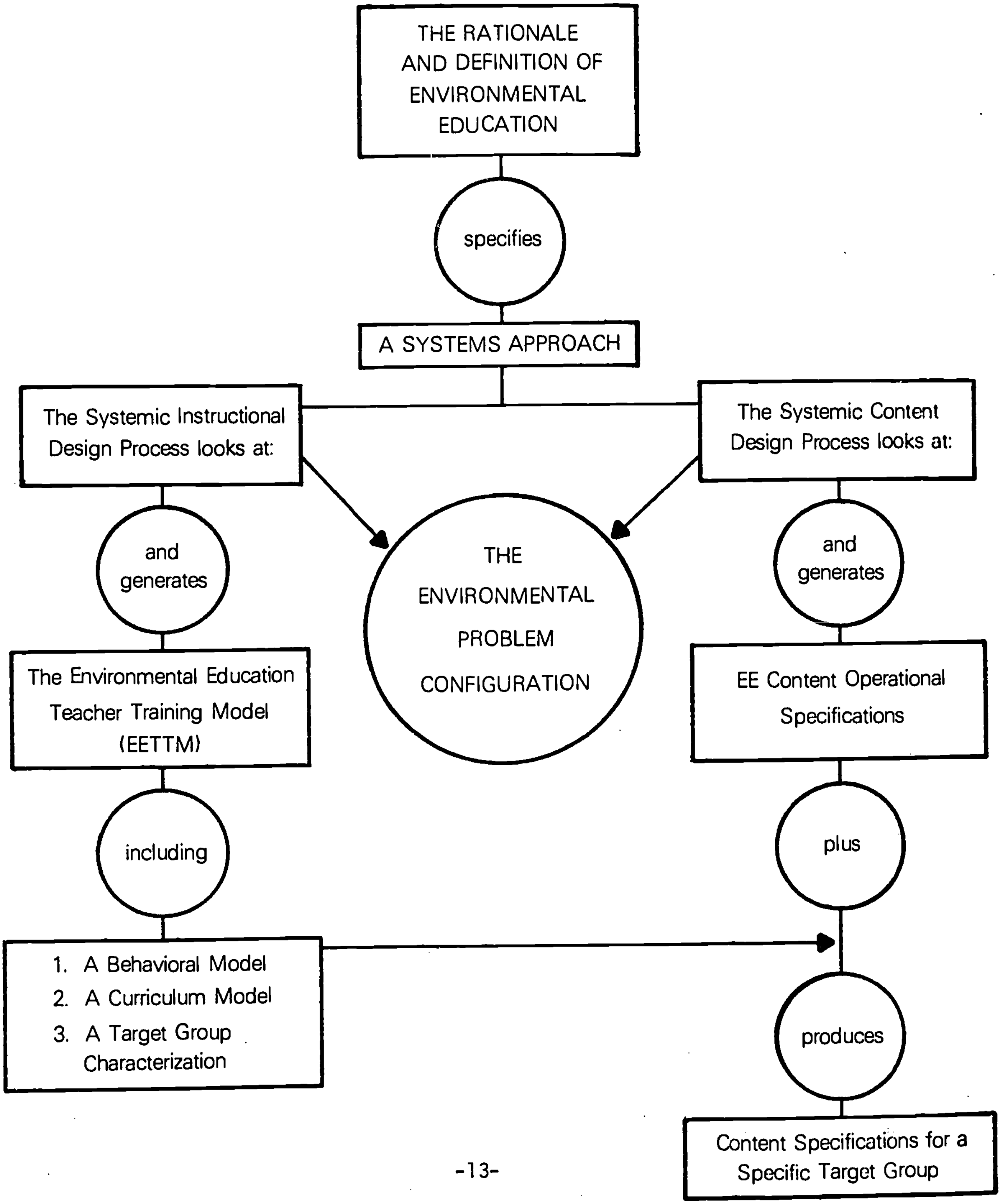
The model must also allow for informing worldview and attitudinal differences by displaying the entire spectrum of environmental values and revealing their implications, consequences and impacts in various environmental contexts. This is the affective aspect of the model.

Also, as an instructional/learning tool, the model must be designed to convey the integrated knowledge and skill components of environmental education which constitute the definition of and guide the development of an environmentally aware person. These components portray the cognitive aspects of the model.

Two processes for use in EE teacher training will be introduced next: the Systemic Instructional Design process which generates the instructional/learning arrangements and the Systemic Content Design

process which generates the Content Specifications. Both processes are originated by interpreting the educational requirements of the environmental problem configuration and by analyzing the systemic nature of the problem from their respective points of view. The following diagram illustrates this point.

Figure 3. AN IMAGE OF A SYSTEMS APPROACH TO ENVIRONMENTAL EDUCATION



PART TWO
SYSTEMIC INSTRUCTIONAL DESIGN

The field of educational development is a goal-directed disciplined inquiry concerned with "...creating new alternatives that contribute to the improvement of educational practice."[1] There are several approaches to this form of disciplined activity.[2] The most recent and comprehensive approach is that of systems development which includes the following activities:[3]

- Analysis and specification of requirements
- Design of alternative solutions and selection of design to be developed
- Development, testing and revision
- Production of the validated form
- Implementation/monitoring and evaluation

From this general development schema, a systemic approach to instructional design has emerged. This approach provides a procedural framework for developing the Environmental Education Teacher Training Model (EETTM). The following sections will: (1) briefly characterize

[1] John K. Hemphill, et al., Educational Development, A New Discipline for Self-Renewal, Eugene, Oregon: University of Oregon Printing Department, 1972.

[2] Hemphill has identified and described two of these approaches: (1) the product development approach which seeks to bring about improvement in educational practice by creating products designed to yield specified outcomes, and (2) the change support approach which attempts to change directly behaviors of those involved in education.

[3] Bela H. Banathy, "On the Contribution of Systems Science to Educational Development," paper presented at American Association for the Advancement of Science, 1976.

this systemic approach, (2) define the conceptual and philosophical principles which guided this endeavor, and (3) describe the manner in which the components which comprise the EETTM were developed.

A. GUIDING PRINCIPLES

A systemic approach to designing the Environmental Education Teacher Training Model enables one to comprehensively address the instructional design challenge represented by the environmental problem configuration addressed by the model.[4] Such an approach, which conceptualizes education as a system, provides a procedural framework for analyzing and synthesizing effective educational research and design strategies into a comprehensive method of planning and development.[5] Within this procedural framework, the purpose and goals of holistic environmental education as defined in the EE Act and portrayed in the environmental configurations are transformed at the model level into components which represent the elements and functions needed to achieve those goals.[6]

Before describing the components which comprise the EETTM and the manner in which they were developed, it is important to identify four major premises or principles related to teacher/learner functions and curriculum design which guided this instructional design endeavor. These principles are:

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[4]See Part Four, Systemic Content Design, for definition of the environmental problem configuration.

[5]Bela H. Banathy, Instructional Systems, Fearon Publishers, Belmont, CA, 1968. Banathy also points to a decision-making structure offered by a systems approach and the manner in which such an approach provides the basis for planned change. For a further discussion of a systems-model approach see Bela H. Banathy, Developing a Systems View of Education, the Systems Model Approach, Fearon Publishers, Belmont, CA, 1973.

[6]EE Act (P. L. 91-516), October 30, 1970.

- teaching as a decision-making process
- learner is the key entity
- integrate rather than re-educate
- curriculum is anticipatory

The first principle is the formulation of teaching as a decision-making process which assigns the selection of instructional/learning arrangements as the significant function of teaching.[7] Within this process, the teacher considers and evaluates the outcomes of alternative instructional/learning arrangements and selects those most likely to accomplish specific learning objectives. Based on an assessment of student needs and interests, the teacher, therefore, is actively involved in making decisions throughout an instructional management sequence of purposing, planning, implementing and evaluating.

This principle of teaching as a decision-making process:

- is based on an analysis and definition of the knowledge, skills and attitudes required by the literate, competent, and aware energy/environmental education teacher
- considers initial trainee competence and previous teaching experience
- develops competences that will enable a teacher to purpose, plan and implement alternative instructional/learning arrangements and to predict and assess relevant learner outcomes
- provides application experiences in which a teacher can plan, design, implement, and see the effects of selected instructional/learning arrangements
- provides for the assessment of instructional/learning outcomes and adjustments in performance based on the assessment

[7] Berliner, David, To Develop an In-Service/Pre-Service Teacher Training Program Demonstrating the Adaptation of Research to Teaching, San Francisco: Far West Laboratory for Educational Research and Development, 1975.

The second principle, highly complementary to the first, is that the learner is the key entity of his/her own instructional/learning system. In the EETTM, the learner is the teacher and instructional/learning arrangements are designed around and in response to his/her assessed needs in order to facilitate mastery of identified tasks. Designing such instructional/learning arrangements involves:

- selection and organization of content and resources which best represent the learning task
- selection and organization of instructional/learning experiences
- assessment of progress
- selection of program formatting elements

The third guiding principle addresses the function of the curriculum specified in the EETTM which seeks to integrate rather than re-educate the teacher. The design is such that teachers can use what they already know to achieve a more holistic understanding and awareness of environmental education. The goal is not to discard previous conceptions and resources but to reorient and reorganize them in a more systemic manner.

Related to and supportive of this integration principle is the fourth principle which specifies the importance of a curriculum which is anticipatory. Such a curriculum displays three characteristics:

- Instructional/learning arrangements are designed to teach organization of information fields, not just to teach information
- Instructional/learning arrangements are experience oriented, not syllabus dominated
- Instructional/learning resources are designed to facilitate the internalization of the development of higher levels of awareness

All of these interrelated principles have contributed to the conceptual design and philosophical orientation of the Environmental Education Teacher Training Model.

The procedural framework for the development of the actual model has been guided by the following broad set of questions which have been identified from a practitioner's (teacher's) point of view:

1. What do I need to know in order to develop a holistic understanding of "man's relationship with his natural and manmade surroundings?"
2. What learning materials and resources do I need to have in order to acquire this understanding?
3. What instructional/learning arrangements need to be made to transmit this understanding to (my) students?
4. What physical and logistical arrangements need to be made for me to master (1) and (3) above?
5. What general guidelines can I use to assess my progress in mastering (1) and (3) above?

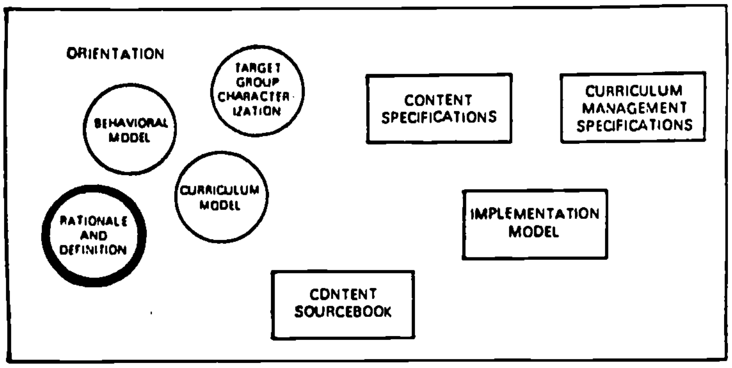
B. THE COMPONENTS OF THE ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL

The components of the Environmental Education Teacher Training Model are designed to address the practitioner questions listed previously, thereby assuring the comprehensiveness of the model. The EETTM components which specifically address each of the questions are listed below.

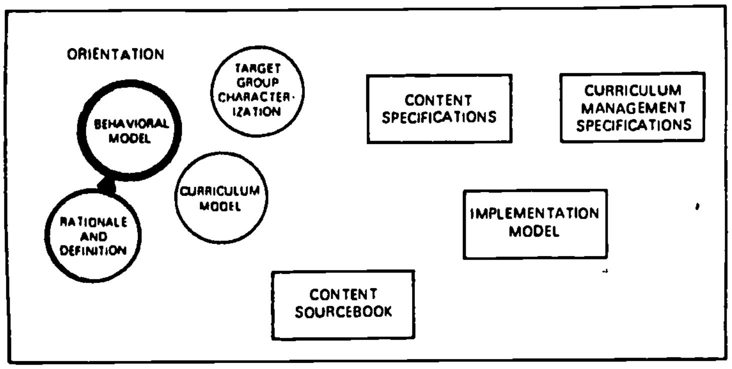
Practitioner Questions	Relevant EETTM Components
• What do I need to know?	CONTENT SPECIFICATIONS
• What materials/resources do I need?	CONTENT SOURCEBOOK
• What instructional/learning arrangements are needed?	CURRICULUM MANAGEMENT SPECIFICATIONS
• What physical and logistical arrangements are needed?	IMPLEMENTATION MODEL
• What general guidelines can I use?	BEHAVIORAL AND CURRICULUM MODELS

The procedural framework for developing each of these components is described below, together with brief descriptions of the components.

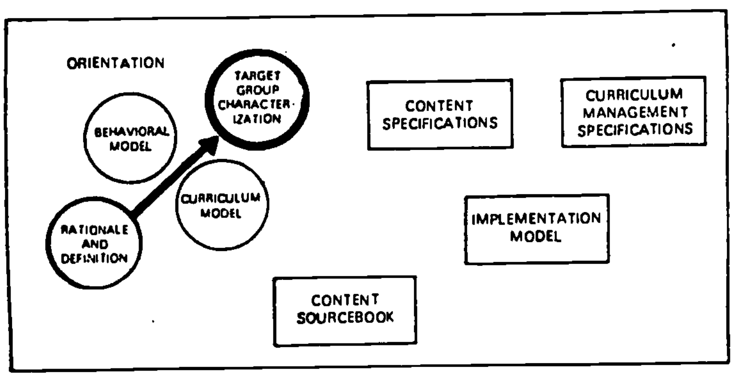
ENVIRONMENTAL EDUCATION
TEACHER TRAINING MODEL



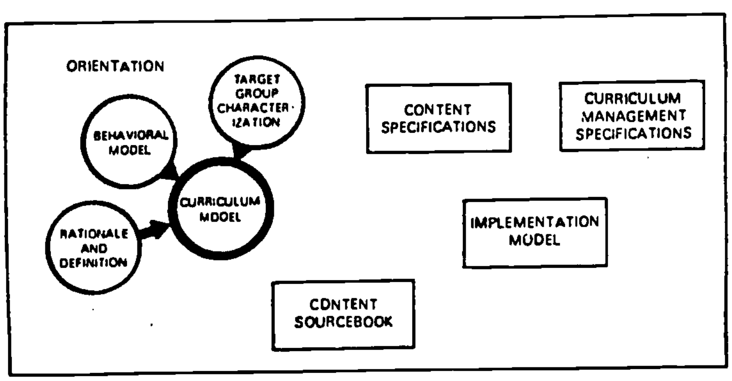
1. The Rationale for and Definition of Environmental Education presents an exposition of the Environmental Education Act as well as a definition of environmental education.



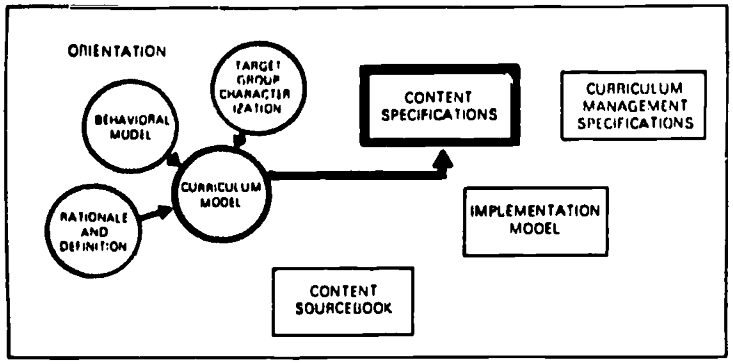
2. The Behavioral Model characterizes the general knowledge, skill and attitude requirements which define the literate, competent, and aware environmental education teacher. It is derived from the Rationale.



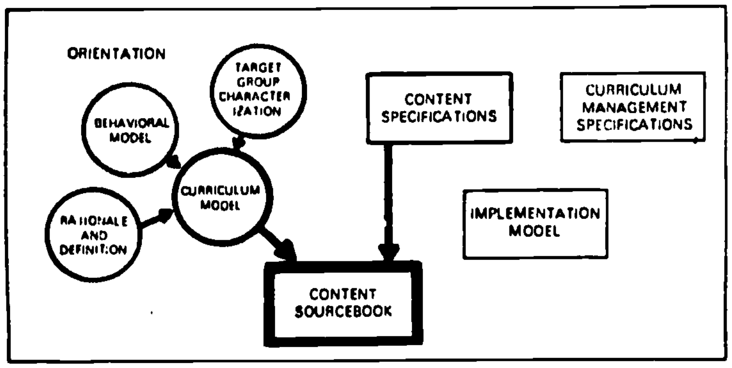
3. The Target Group Characterization defines the target group as K-9 natural science and 4-12 social science teachers and provides a means to assess their current level of competence in order to ensure the model's compatibility with their needs.



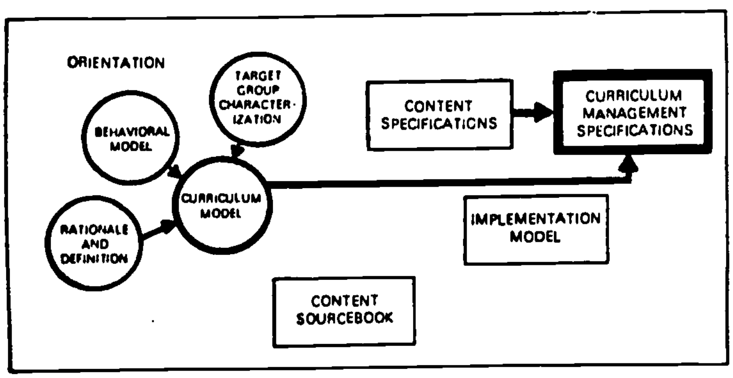
4. The Curriculum Model provides an organized description of the various curriculum content domains within which potential teachers need to attain competence. It is consistent with the Rationale and represents an elaboration of the Behavioral Model and the Target Group Characterization.



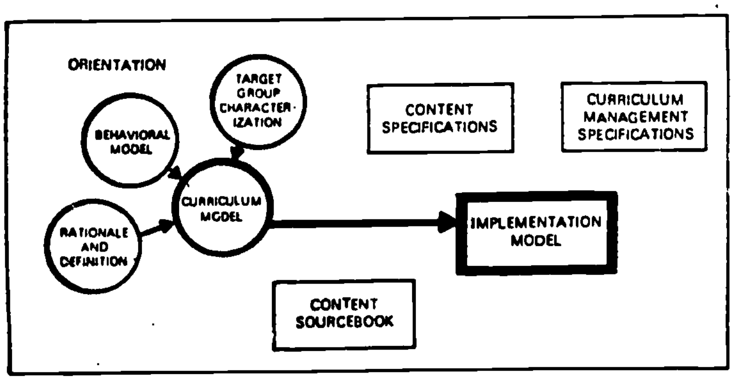
5. The Content Specifications present the knowledge components for environmental education and a description of their instructional foci and purposes. These specifications were designed to satisfy the requirements of the knowledge component of the Curriculum Model.



6. The Content Sourcebook presents an elaborated discussion of the knowledge components of the content model, a subject matter/cultural process matrix, an annotated resource bibliography and glossary. The requirements for the Sourcebook are defined by the Curriculum Model and the Content Specifications.



7. The Curriculum Management Specifications provides general instructional arrangements by which teachers can purpose, plan, implement and evaluate an environmental education curriculum. This component was derived from and further elaborates the skills component of the Curriculum Model and the Content Specifications.



8. The Implementation Model presents the conceptual bases and functions of the implementation process together with characteristic activities associated with each phase of the process. The implementation design was guided by the Curriculum Model.

PART THREE
SYSTEMIC CONTENT DESIGN

Systemic Content Design is a holistic approach to perceiving the environmental problem configuration[1] as the interactions between the total systems of humanity and nature. Since the Environmental Education Act was developed as a response to public opinion toward the undesirable effects of some of these interactions, the primary orientation of content design is toward a problem-solving approach. This approach is viewed, in turn, within the overall context of complex decision-making ranging in scale from individual decision-making to multi-national corporate and international governmental decision-making.

Systemic Content Design utilizes an anticipatory planning/design process and develops a content specification to be used within each Environmental Education Teacher Training Model. The anticipatory planning/design process is a synergetic procedure of including contingencies and alternatives in the feedforward mode, as opposed to reflecting on error signals as feedback, and making corrections. Neither mode by itself is ideal. Actually, an interaction between feedforward and feedback is the most desirable mode, as it stimulates evolution and the capability to switch between states of dynamic

[1]The "environmental problem configuration" is defined as the interactions of systems of humanity and nature in a values laden context.

equilibrium.[2] Personal experience with this anticipatory process develops the individual's intuitive awareness of the holistic "systemness" of human-environment interactions. This "systemness" of human-environment interactions will never be entirely concrete or completely understood. To have this as a goal is to misunderstand the utility of systems thinking.[3] An understanding of the systemic qualities of human-environment interactions is necessary so that their "signals" of dysfunction can be recognized in an anticipatory mode rather than in a reflective mode which is after the fact.

Most people view themselves as separate from the system they are interacting with. To be comprehensive and holistic, therefore, one must include him/hersefl as part of the "whole system" which is being manipulated or interacted with. To be anticipatory, one must take into account contingencies surrounding the "whole system" for their potentially useful or harmful effects.

[2] Jantsch, Erich, Evolution and Consciousness, Reading, Mass.: Addison-Wesley Publ. Co., 1976.

[3] Gall, John, Systemantics, New York: Quadrangle/New York Times Book Co., Inc., 1977.

A. ORGANIZING INFORMATION FIELDS

The content specifications interpreted from the EE Act and the definition of EE are very complex and all encompassing. The whole range of humanity and natural system interactions includes every aspect of American culture and society. The task of organizing all the facts and data concerning every aspect of American culture and society according to EE is not a realistic one. As certain data are arranged into meaningful information to illuminate one domain of EE, another domain is surely diminished by this arrangement. To counteract this, data must not be regarded as "belonging" to any one field or discipline. In integrative, transdisciplinary EE, data must be flexible, and be arranged for specific purposes that are known or anticipated in advance of the arranging process.

The organizing element of the method of arranging data is a protocol or form of conduct which, as a process, has its own integrity. In organizing data into meaningful information for the specific purposes of EE, one of the main criteria for maintaining the integrity of this process is a comprehensive systems approach which functions as a guiding protocol for all EE activity.

This integral, comprehensive systems approach to EE content regards data as fields of information loosely connected in an elastic network of associations. The intrinsic qualities of these richly interconnected associations are illuminated or heightened by the specifications of the particular arrangements desired--the goal and

the purposive focus for organizing the information.[4] Content entities are manipulated as an elastic figure-ground network, where an entity can be featured (figure) in one particular arrangement and supporting (ground) in another. To further complicate the picture, a content entity can be regarded differently in several arrangements simultaneously.

Without a formal set of hierarchical classifications, a systemic approach to EE content must first generate its protocol or rules for making meaningful information arrangements. These arrangements must organize fields of information that illuminate specific EE problem configurations.

The following discussions of goal-oriented/process-oriented systems and integrative frameworks are oriented toward this task.

[4]For example, given a specific situation such as the fish are dying in San Francisco Bay, imagine the many ways the relevant facts and data could be organized to illustrate the many factors contributing to the situation. It could demonstrate the effects of landfilling, industrial waste outflow, urbanization, or the poor coordination of the various canal systems that feed the Bay. To compound the difficulty of the problem, the data organization can be designed to favor a certain point of view as representative of the "truth of the matter." In fact, every institution involved in the situation will design its own data organization that will reflect its own function--regulatory agencies, citizen's interest groups, or academic groups. Obviously, they all contribute to the "truth of the matter."

B. GOAL-ORIENTED AND PROCESS-ORIENTED SYSTEMS

Natural systems are process-oriented systems: an organism adapts its processes to achieve harmony with the processes of its environment. If its surrounding environment is complex and/or quickly changing, the organism must invest large quantities of time and energy in: (1) isolating itself from the changes in its environment by constructing buffers and accumulating storages, or in (2) developing structural mechanisms that can adapt and respond quickly to the new conditions. Either strategy is potentially "harmonious." Harmony, literally means "parts in syncopated rhythm." And survival in organism/environment relationships focuses more on coordinating the rate of changes than on a particular strategy. In natural systems, relationships are formed around mutually reinforcing processes.

The various components of the human system, on the other hand, are largely goal-oriented subsystems. Individuals, groups, and institutions of Western culture are all primarily goal-oriented. In the human system we rarely design processes except in terms of the product they are to produce or the goal they are to reach. The pre-eminence of rationality in Western thought has emphasized purpose, logical reasoning, and evaluation of the product generated, to the point where these steps in the process are specialized entities in themselves. All too frequently these steps compete with one another for overall controlling power of the process involved and thereby often jeopardize the holistic integrity of the entire process.

Attempts to generate an overall coordinating entity are met with resistance from threatened territorial domains, rather than embraced

as necessary overall navigational aids. The navigational aids, however, are not without their potential pitfalls. If the overall coordinating activity of navigation is perceived as just another specialized role, then the navigators are obliged to carefully plot the exact location as the ship sinks. To paraphrase Kenneth Watt in The Titanic Effect, we spend most of our time developing studies of how to arrange the deck chairs on the sinking Titanic.[5]

Although learning is a process very much akin to organic evolution, our educational systems are goal or product-oriented rather than process-oriented. Unfortunately, this focus upon goal accountability has shifted the emphasis from facilitating educational experiences to evaluating them, and in fact has curtailed the development of educational experiences that are difficult to evaluate. The EE effort emphasizes the necessary relationship between goal and process-oriented systems and cautions against emphasizing one over the other.

The acknowledgement of both the natural system, process-oriented, and the human system, goal-oriented, points to an important source of basic difference which contributes to the increasing adversary nature of the two systems. The "meshing" or successful coupling of the two systems depends on their being in the same temporal framework. This means literally being in time. Even the best conceptual strategy is useless if not operationalized in time and properly phased with the ongoing activity. When two systems are not tuned to the same temporal beat, there is interruption in the flows between the systems. In the

[5]Watt, Kenneth, The Titanic Effect, New York: E. P. Dutton & Co, Inc. 1974.

case of the natural and human systems, this interruption assumes the forms of resource shortages and/or excessive pollution.

An example of this kind of interruption is the well known practice of commercial agriculture in this country. Cash crops are planted year after year and eventually the yield diminishe due to depletion of soil nutrients. This prompts the application of commercial fertilizers which increases the yield and adds to the price. The continued addition of fertilizer year after year to maintain the higher yield eventually results in a loss of surrounding water quality as the runoff waters filter through the petro-chemical saturated soil. The long-term possibility of maintaining crop yield and soil health by other organic agricultural practices is sacrified by the short-term goal of ever-increasing crop yields.[6] The resulting unhealthy conditions are far more costly in energy and money to restore than to prevent. Proper agricultural practices that maintain long-term soil health have been known by many cultures for centuries. The basis for the present condition in America is lack of environmental awareness and a favoring of goal achievement rather than proper process practices.

[6] For a discussion of nurturing and exploiting the land, see Wendell Berry, The Unsettling of America, San Francisco: Sierra Club Books, 1977.

C. INTEGRATIVE FRAMEWORKS: STRUCTURE AND PROCESS

Both the Environmental Education Act and the Arizona Report stress the necessity for the construction of an integrative framework for the content of environmental education.[7,8] In the wording of the Arizona Report, the primary recommendation is "to develop core themes and a conceptual structure in environmental education that synthesizes and integrates pertinent subject matter across and between a variety of traditional disciplines."[9]

This report does not characterize an integrative framework, but it does identify the following certain key concepts or themes that are common to various disciplines and can serve as conceptual structures of integration:

- Environmental Unity
- General Systems Approach
- Energy Flow
- Economics
- Human Settlements or Ekistics

Synthesizing and integrating these structural themes and concepts in an application of the decision-making/problem-solving process requires process-oriented tools and strategies. Two such integrative techniques are:

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[7]EEA, P. L. 91-516, 1970.

[8]Arizona State University Center for Environmental Studies and Association of American Geographers, Environment-based Environmental Education: Inventory, Analysis, and Recommendations, June, 1975.

[9]Arizona Report, p. 1.6.

1. Information Organization Frameworks designed to collect, organize and store information.

2. Metalanguages which develop a language that can incorporate the elements of various disciplines

1. Information Organization Frameworks

Information organization frameworks may be considered as static or dynamic, outer or inner. Static integrative frameworks have the property that additional information inputs must be placed into the most suitable 'boxes' which exist for the incorporation of new material. Examples are libraries, expandable files and unifying schemata such as the periodic table of chemical elements.

Dynamic integrative frameworks, on the other hand, are anticipatory with respect to new information and include in their structure a reorganizing process for restructuring the file so that it not only has 'boxes' for new material, but all these 'boxes' reflect the most logical organization of all the material. "Sleuthing" or investigating obscure information is an example of an anticipatory reorganizing process in that new "facts" can completely change the organization of the file. Only dynamic files are integrative in the full meaning of the term.

Outer or external integrative frameworks are those that organize information of a tangible and practical sort: facts, data, processes, plans and activities. These systems may be either static or dynamic as defined above.

Inner integrative frameworks organize and process information of a non-physical nature. Typical materials include beliefs, values, worldviews and personal psychological materials such as images,

fantasies, and dreams. Inner integrative systems are necessarily dynamic since the processing of this sort of information, whether cultural or personal, invariably restructures or alters the system.

The flexible nature of EE data indicates that dynamic files of both inner and outer types be included in the comprehensive approach to EE content.

2. Metalanguages

The types of information to be processed in environmental education come in many separate "languages": economics, biology, ecology, chemistry, law, etc. In order to organize the vast and varied fields of information, a "metalanguage" is needed. Such a language would reflect the transdisciplinary nature of environmental education. This metalanguage would be capable of both organizing information and incorporating new information in an organized manner. Using a metalanguage, statements can be made of sufficient generality to unify and coordinate the propositions already validated within the original disciplinary domains.

Mathematics is a kind of metalanguage that is based on abstraction according to quantity. It is an attractive metalanguage because of the inferential and predictive capabilities of its numbers, measurements, and statistics.

There is also a metalanguage of systems which is based on abstraction of certain processes. These processes such as feedback, hierarchy, energy flow, are common to a large class of systems. The focus of this abstraction is to reveal deeper and more subtle essences

of a system's structure <u>or</u> process without losing the ability to make precise statements at every level.

Both mathematics and systems are abstract metalanguages that focus on <u>micro-patterns</u> common to all domains. A second type of metalanguages searches for <u>macro-patterns</u> in the universal domain. It is a more holistic language in that it is applicable to larger domains. But as the field of view is increased, the ability to see fine detail is reduced.

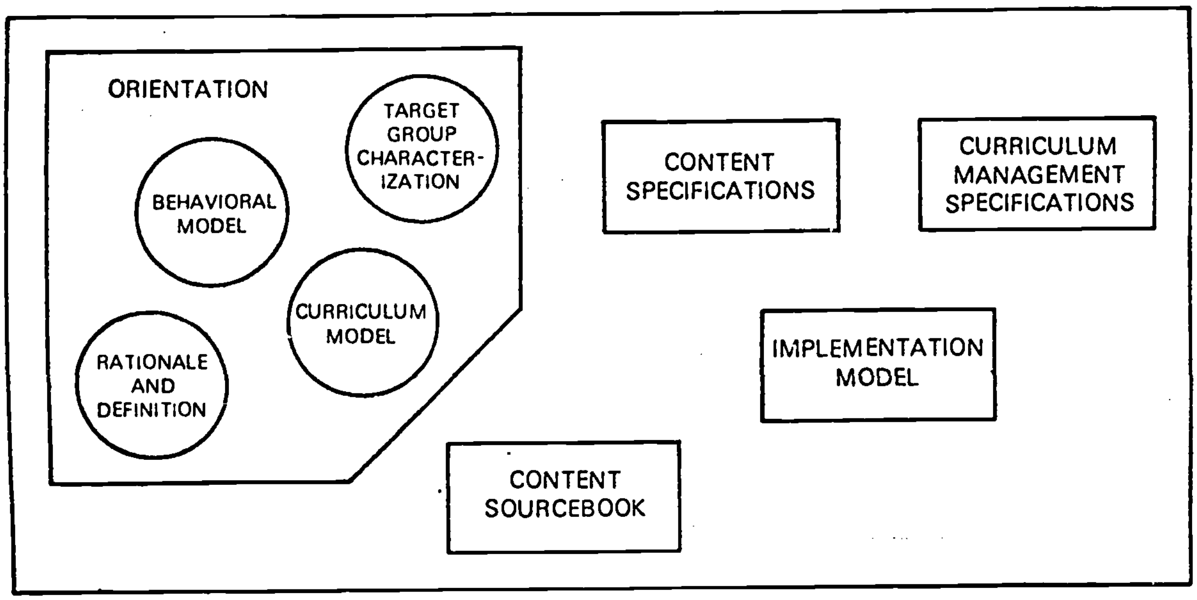
What will emerge however, as the result of viewing a larger field, are new patterns previously imperceptible either because the field was too small or there were too many details to see the overall pattern.

The oldest metalanguage of this type consists of the themes of folklore which are general statements through which many specifics are mapped onto a single expression or symbol: a line of verse or an archetypal folktale. Folklore, mythology and poetry are all metaphorical languages that communicate by analogies and indirect references. They are holistic in that they are de-focused from exact descriptions, but rather are applicable to larger domains.

These two kinds of metalanguages, the <u>abstract</u> and the <u>metaphoric</u> allow us to unify and integrate our descriptions of the world. This, in turn, makes it possible to transfer this knowledge from one situation to another. In environmental education both kinds of metalanguages are used.

PART FOUR
A DESCRIPTION OF EETTM DOCUMENTS AND INTENDED USERS

The components of the instructional design process displayed below have been translated into the documents comprising this teacher training model.



ENVIRONMENTAL EDUCATION
TEACHER TRAINING MODEL

Each document addresses a particular component except for the one designated "Orientation."

A. DOCUMENTS

1. Orientation

In addition to introducing a systemic approach to the instructional and content domains of holistic, environmental education, this guide contains:

- Rationale and General Definition of Environmental Education
- Behavioral Model
- Target Group Characterization
- Curriculum Model

2. Content Specifications

The Content Specifications describe the components of the environmental education content model. These components represent a conceptualization of the basic set of indicators and processes for gauging or explaining the changing integration of all EE entities over time within a given environmental context. These components are as follows:

- Environment-related Decisions
- Problem-solving and Decision-making
- Analytical Tools for Understanding Environmental Systems
- Resource Delivery Systems
- Holistic Lifestyle Assessment
- Forecasting, Planning, and Policy Formation
- Futures Thinking

These content components emphasize three major aspects of any environmental context:

Complexity:	any context is a complex system with many parts and processes
Integration:	all parts within a context system are interrelated and each part affects and is affected by the other parts
Dynamic nature:	the integration (nature and degree of interrelationship, interaction) of the parts within a context system change over time

When linked appropriately to other components of the Environmental Education Teacher Training Model (i.e., Curriculum Management, Content Sourcebook), these content components constitute the major element in designing and developing holistic environmental education curricula.

3. Content Sourcebook

The Content Sourcebook provides an extensive resource base for developing instructional/learning materials. The Sourcebook presents:

- an elaborated description of each of the components depicted in the Content Specifications together with an annotated bibliography and glossary

- a curriculum map in the form of a matrix of environmental education subject matter and basic processes of the culture. It is intended to help environmental educators: (1) identify and select potential EE curriculum content from the perspective of their professional subject matter or processes competence and interests, and (2) associate EE subject matter and cultural processes with appropriate EE principles and concepts, learning materials and other resources, and learning/competence objectives.

- instructional/learning resource materials organized according to the following classifications:

  (1) Issues of National Priority (e.g., long-term utilization and conservation of coal resources)
  (2) Key Environmental Entities (e.g., pollution, conservation, technology)
  (3) Settings of Environmental Interest

4. Curriculum Management Specifications

The Curriculum Management Specifications describe a general instructional management sequence consisting of four interrelated components which describe the steps or operations associated with purposing, planning, implementing and evaluating an environmental education curriculum. These specifications describe arrangements by which teachers can:

- select, develop and implement an environmental education curriculum geared to their students' needs and abilities
- evaluate and adjust specific learning objectives, curriculum content, or instructional strategies as needed to enable students to achieve a desired level of environmental awareness

5. Implementation Model

The Implementation Model provides a structure/process view of the implementation process which is based on the interrelationships among the following components:

- Institutional Management System
- Learning Facilitation System
- Instructional/Learning System
- Application System

These components describe characteristic activities associated with instructional and institutional arrangements needed to plan, implement and evaluate a comprehensive and effective environmental education teacher training program in a variety of settings.

B. INTENDED USERS

The documents described in the previous section address the components of the Environmental Education Teacher Training Model. They may be used in a variety of ways, depending on the purposive focus and goal of the intended user. The relationships between intended users and these documents is presented in the following pages and summarized in Table One.

1. Educational Research and Development Organizations

   Example: Far West Laboratory for Education Research and Development, Educational Development Center, American Institutes for Research, SRI (Stanford Research Institute)

   Application: Use all documents to produce EE training products at the modular, component or program level

2. International EE Organizations

   Example: World Education, International Union for the Conservation of Nature and Natural Resources

   Application: Use all documents to assist in:

   - developing new training products
   - developing criteria for evaluating existing programs
   - developing guidelines for future funding efforts

3. Professional Education Associations

   Example: National Science Teachers Association, National Council for the Social Studies, Conservation Education Association

   Application: Use behavioral, curriculum and content models as basis for assessing teachers' current knowledge, skill and attitudinal competences and making recommendations for changes in teacher preparation programs

   Use all documents to develop criteria/guidelines for recommending future research and development efforts

   Use Content Specifications and Content Sourcebook to develop series of introductory articles in professional magazines as to "what constitutes holistic energy/environmental education," etc.

4. Energy/Environmentally Concerned Federal, State and Local Governmental Agencies

Example: Energy Research and Development Administration, California Conservation Corps, Natural Resource Department

Application: Use Content Specifications and Content Sourcebook to generate criteria and guidelines for policy/decision-making regarding program and personnel development

5. State Environmental Directors and Training Personnel

Example: Department Public Instruction

Application: Use all documents to develop criteria for assessing existing state plans and making recommendations for future changes

Use Content Specifications and Content Sourcebook (descriptions and annotated bibliography) as basis for presentations, structuring conferences, and making recommendations to the legislature regarding curricula changes

6. Universities

Example: Teacher Education Departments

Application: Use behavioral and curriculum model to assess their array of competences

Use all documents to develop course(s) to provide opportunity for secondary teachers to become proficient in planning, developing and implementing energy/environmental education courses

Example: Environmental Studies Institutes

Application: Use Content Specifications and Content Sourcebook to develop criteria and guidelines for assessing comprehensiveness of existing curricula or establishing an interdisciplinary energy/environmental program at the B.S. or M.S. level

7. Curriculum Specialists/Developers at School District Level

Application: Use behavioral and curriculum model to assess teachers' current level of competence

Use Content Specifications, Content Sourcebook and Curriculum Management to develop criteria to assess current programs and make recommendations for future training

Use Implementation Model to develop effective implementation plan

8. State and Federal Legislative Staff and Committees Concerned with Energy, Energy/Environmental Education

   Application: Use Content Specifications and Content Sourcebook to develop criteria for reviewing legislation

9. Energy/Environmentally Concerned Youth Groups

   Example: Boy Scouts, Girl Scouts, 4-H

   Application: Use all documents to develop guidelines for assessing current energy/environmental education projects/programs and/or developing new ones

10. Publishing Firms

    Example: Harcourt Brace Jovanovich, MIT Press, Scott, Foresman and Co.

    Application: Use Content Specifications, Content Sourcebook, Curriculum Management to develop criteria and guidelines to assess materials submitted and to commission development of new interdisciplinary series

11. Educational Television

    Example: Instructional Television Divisions of PBS at national and local level

    Application: Use Content Specifications and Content Sourcebook to develop guidelines for program development

12. Energy/Environmentally Concerned Community Groups

    Example: Sierra Club, Farallones Institute, Friends of the Earth, League of Women Voters

    Application: Use all documents to develop guidelines for assessing current energy/environmental education projects/programs and/or developing new ones

TABLE ONE

POTENTIAL USERS AND APPLICATIONS FOR THE EETTM

INTENDED USERS AND APPLICATIONS	DOCUMENTS ASSESSING MODEL COMPONENTS: Content Sourcebook — Subject Matter/ Process Matrix	Content Sourcebook — Content Descriptions	Content Sourcebook — Annotated Bibliography	Orientation — Rationale[1]	Orientation — Behavior Model	Orientation — Curriculum Model	Content Specifications	Curriculum Management	Implementation
1. Educational Research and Development Organizations • Producing training products	*	*	*		*	*	*	*	*
2. International EE Organizations • Developing training products • Developing program evaluation criteria • Developing future funding guidelines	*	*	*		*	*	*	*	*
3. Professional Education Associations • Assessing teacher competence • Recommending future R&D • Developing publications	* *	* *	* *		* *	* *	* * *	*	*
4. Energy/Environmentally concerned Federal, State and Local Governmental Agencies • Generating criteria and guidelines for policy and decision-making	*	*	*				*		
5. State Environmental Directors and Training Personnel • Assessing state plans • Making legislative recommendations	* *	* *	* *		*	*	* *	*	*
6. Universities • Assessing teacher competence • Developing teacher training programs • Assessing existing curricula/programs	* *	* *	* *		* *	* *	* *	*	*

[1]Rationale in the Orientation Manual is essential for all intended users to address because it orients the reader to the domains of holistic energy/environmental education.

TABLE ONE (Continued)
POTENTIAL USERS AND APPLICATIONS FOR THE EETTM

INTENDED USERS AND APPLICATIONS	DOCUMENTS ASSESSING MODEL COMPONENTS								
	Content Sourcebook			Orientation			Content Specifications	Curriculum Management	Implementation
	Subject Matter/ Process Matrix	Content Descriptions	Annotated Bibliography	Rationale[1]	Behavior Model	Curriculum Model			
7. Curriculum Specialists/Developers at School District Level									
• Assessing teacher competence					*	*			
• Developing program assessment criteria	*	*	*				*	*	
• Developing program implementation plans									*
8. State and Federal Legislative Staff and Committees									
• Developing legislative review criteria	*	*	*				*		
9. Energy/Environmentally concerned Youth Groups									
• Assessing projects/programs or developing new ones	*	*	*		*	*	*	*	*
10. Publishing Firms									
• Assessing or commissioning publications	*	*	*				*	*	
11. Educational Television									
• Developing guidelines for program development	*	*	*				*		
12. Energy/Environmentally concerned community groups									
• Assessing projects/programs or developing new ones	*	*	*		*	*	*	*	*

PART FIVE
BEHAVIORAL MODEL

The purpose of the Behavioral Model for Environmental Education Teacher Training is to characterize the gneral knowledge, skill, and attitude requirements which define the environmentally literate, competent, and aware teacher, and which are consistent with the mission of the Office of Environmental Education as defined by the Environmental Education Act of 1970.

A. GENERAL KNOWLEDGE REQUIREMENTS

The general knowledge requirements of the Behavioral Model characterize the environmentally literate Natural Science teacher as one who understands basic environmental concepts and principles, and the processes and factors to be utilized or considered in comprehending environmental systems, and in identifying and evaluating solutions to environmental problems.

These general requirements include an understanding of:

1. The significant relationships within and between environmental systems and sub-systems (both natural and man-made).
2. The requirements (needs) and impacts (need satisfaction, problems, conflicts) of these relationships.
3. The reciprocal effects of human activity in terms of environmental balance and quality.
4. The holistic contexts (natural and man-made) within which environmental problems and problem solutions must be viewed for comprehensive, responsible, and future-oriented decision-making.
5. Processes of inquiry and decision-making appropriate to interpreting, analyzing, and evaluating environmental issues and problems.

B. GENERAL SKILL REQUIREMENTS

The general instructional skill requirements of the Behavioral Model characterize the environmentally competent natural science teacher as one who is able to purpose, plan, implement, and evaluate instructional/learning arrangements which infuse selected environmental education content into a traditional Natural Science curriculum. This infused curriculum would, furthermore, be designed to meet standard Natural Science learning objectives while, at the same time, transmit to students an understanding of environmental subject-matter, concepts, principles, and processes, and develop in them the capability of dealing with environmental phenomena, problems, and issues from a holistic, transdisciplinary perspective.

These general skill requirements include the abilities to:

1. Purpose an environmental education curriculum for infusion into Natural Science by setting environmental awareness learning objectives which are "goals compatible" with the host curriculum and the curriculum to be infused, and which are consistent with students' abilities and needs.

2. Plan an environmental curriculum by selecting appropriate environmental content and selecting suitable instructional/learning arrangements to convey the content to students.

3. Implement instructional/learning arrangements which convey the environmental content to students.

4. Evaluate the effectiveness of the instructional/learning arrangements in facilitating students' attainment of environmental awareness learning objectives, making suitable adjustments in these objectives or arrangements where necessary.

C. GENERAL ATTITUDE REQUIREMENTS

The general practice or attitude requirements of the Behavioral Model characterize the environmentally aware Natural Science teacher as one who demonstrates through words and actions:

- an appreciation of the complex, holistic, and trans-disciplinary nature of environmental systems, and environmental problems and issues which are produced by and which affect humanity-environment relationships

- a willingness to develop this same appreciation in students by encouraging active interest and participation in environmental decision-making at both the individual and societal levels

These general requirements include demonstrating:

1. A tendency to use both cognitive (analysis/synthesis/evaluation) and affective (valuing) processes or tools coupled with the knowledge bases of various disciplines in a highly integrative manner when studying or discussing environmental problems and issues with students.

2. A tendency to seek out and emphasize humanity-environment relationships which lead to "productive harmony" regarding environmental quality.

3. A tendency to search for and discuss environmental policies and programs which reflect long-range, as well as short-range, concern for environmental quality.

4. A willingness to consider physical, psycho-social, economic, cultural and other factors in addressing environmental problems.

5. A tendency to encourage individual responsibility in making lifestyle and career choice decisions that are consistent with holistic, long-range strategies for achieving environmental quality.

6. A tendency to encourage students to commit themselves to coping holistically, systemically, and scientifically with environmental questions and issues.

PART SIX

TARGET GROUP CHARACTERIZATION

The purpose of the Target Group Characterization is to provide the curriculum designer with a description of: (1) the instructional/learning context of science education into which environmental education will be infused, and (2) the prospective teacher trainees.

The specified instructional/learning context is the K-9 natural science curriculum. It is characterized here in terms of its conceptual bases, goals and objectives, curricular organization, sequencing of content and teaching strategies.*

The characterization of K-9 science teachers is based on consideration of: preservice preparation and teacher competences in the areas of science, liberal arts, instructional methods and techniques, and professional education.**

* This characterization was based on the following types of sources: State documents such as Science Framework for California Public Schools and the Wisconsin Guide to Science Curriculum Development, NSTA and AAAS publications, journal articles, and texts. See Selected Bibliography for a complete list of these sources.

**This characterization was based on examination of various college catalogs; NSTA publications; and The Education of Science Teachers by J.S. Richardson et al. See Selected Bibliography at the end of this section.

A. INSTRUCTIONAL/LEARNING CONTEXT OF SCIENCE EDUCATION

1. Conceptual Bases of Science Education

a. Nature of Science Education

California State Advisory Committee on Science Education	Science teaching plays an important role in "inventing the future, that we as a people, desire and for assuring the intellectual resources needed to attain that future." Curriculum guidelines must therefore be derived which look more to the future. The proper study of science must stress the development of processes and attitudes of scientific inquiry.
NSTA Curriculum Committee	Science education must be based upon "ideas which have survival value--not upon trivia." Consequently, the task of science education becomes "identification of major generalizations or concepts in science and methods of instruction most successful for imparting to students an understanding and appreciation of these concepts or intellectual achievements of science."
Wisconsin Department of Public Instruction	The science curriculum should recognize: (1) the need for an investigative laboratory experience for students, and (2) the need for educating children at all levels in the nature of the scientific enterprise.

b. Nature of the Learner

California State Advisory Committee on Science Education	The most prominent characteristic of the learner is his/her uniqueness as an individual. This suggests that the intellectual growth of all students requires a curriculum with different kinds of learning components that are "taught through a rich array of instructional techniques, paced at a rate that assures individual mastery, and designed to bring every child to his maximum potential as a self-directed learner."

c. Role of the Teacher

California State Advisory Committee on Science Education	The science teacher is not a transmitter of factual information, but rather one who creates the conditions in which the student discovers what the universe is about.

2. Goals and Objectives of Science Programs

California State Advisory Committee on Science Education

Goals and objectives should be stated in operational terms. These "operational objectives" are behavioral descriptions of what the students will be able to do as a result of instruction. They are derived from and are consistent with the goals of the program.

Three levels of objectives are designated:

- terminal objectives (broad, end-of-school)
- interim objectives (end of unit or course)
- learning-step objectives* (single lesson)

The goals for the California Science Program are:

1. To develop those values, aspirations, and attitudes which underlie the personal involvement of the individual with his/her environment and with mankind.
2. To develop the rational thinking processes which underlie scientific modes of inquiry.
3. To develop fundamental skills in manipulating materials and equipment and in gathering, organizing, and communicating scientific information.
4. To develop knowledge of specifics, processes, concepts, generalizations, and unifying principles, which leads to further interpretation and prediction of objects and events in the natural environment.

* The teacher has primary responsibility for deriving and ordering this level of objectives.

3. Curricular Organization

In the past, content structures have served as the organizing basis for science programs at all levels. Topics drawn from physics, chemistry, and biology were the principal organizational components at the elementary level. Some elementary science programs, for example, were developed around content strands such as:

Animals and their Surroundings
The Human Body
Living Plants
Our Solar System
Matter and Energy
Magnetism and Electricity
The Head and its Actions

In the past twenty years, however, science educators have determined that science programs should be based on sets of related ideas (concepts) and investigative processes. These concepts and processes provide the structure upon which the science curriculum is built.

Three conceptual frameworks and process organizational schemes for K-12 science curricula are outlined on the following pages.

a. <u>California State Advisory Committee on Science Education</u>

The major conceptual systems identified by this Committee are:

(1) Most events in nature occur in a predictable way, understandable in terms of a cause-and-effect relationship; natural laws are universal and demonstrable throughout time and space.

(2) Frames of reference for size, position, time and motion in space are relative, not absolute.

(3) Matter is composed of particles which are in constant motion.

(4) Energy exists in a variety of convertible forms.

(5) Matter and energy are manifestations of a single entity; their sum in a closed system is constant.

(6) Through classification systems, scientists bring order and unity to apparently dissimilar and diverse natural phenomena.

(7) Units of matter interact.

The purpose of the conceptual systems is to identify the content of the K-12 curriculum. They represent the long-range goals of instruction.

These conceptual systems, together with the major rational thinking processes provide the sequencing and organization of content for K-12 science curricula.

The rational thinking processes are:
- observing
- experimenting
- verifying
- predicting
- organizing
- inferring
- analyzing
- synthesizing
- generalizing

b. Wisconsin Department of Public Instruction

The Wisconsin framework organizes the science curriculum around four areas:

(1) Six major conceptual schemes: diversity, change, continuity, interaction, organization, and limitation. These six schemes are further stated in terms of biological science, physical science and earth science resulting in a total of 18 major concepts.

(2) The processes of science: observing, classifying, inferring, predicting, measuring, communicating, interpreting data, making operational definitions, formulating questions and hypotheses, experimenting and formulating models.

(3) The Nature of the scientific enterprise: what a scientist is, what a scientist does, what a scientist believes, and how he or she conducts investigations.

(4) The cultural implications of science which portray the main interrelationships between science and human activities on both intellectual and physical grounds. Science influences and is influenced by the following kinds of human activities: aesthetic, philosophical, economic, political and sociological.

c. AAAS Commission of Science Education

Certain processes are viewed as basic activities for the learning of science.

Basic processes emphasized in the primary grades are: observing, classifying, using space/time relations, using numbers, communicating, measuring, inferring, and predicting.

Integrated processes emphasized in the intermediate grades are: formulating hypotheses, controlling variables, interpreting data, defining operationally, formulating models, and experimenting.

4. Sequencing

The sequencing of content and/or processes from the early to the later grades does not appear to follow any clear set guidelines except those specified by the students' developmental levels. Nearly all topics within the range of a student's comprehension may be found at nearly all levels. This also holds true for the processes.

a. California State Advisory Committee on Science Education

Their conceptual schema is characterized at three different levels of sophistication but provides no guidelines for allocating them according to grade levels. This task is relegated to the individual teacher and seems determined, to a large extent, by the instructional materials already being utilized in the classroom.

b. Wisconsin Department of Public Instruction

Ten levels of increasing sophisitications are designated for the six major conceptual schemes listed above. Also, each of the eleven processes of science were developed into sequential hierarchy of behaviors within the process and then correlated to the ten levels. For example, observing was broken down into ten subprocesses (a-j) such as:

- distinguishing differences in physical properties of objects by direct observation.
- manipulating or changing an object in order to expose its properties for observation.

These subprocesses (a-j) were then correlated to the ten process levels:

Process Level	0	1	2	3	4	5	6	7
Observing	ab	c	d e	f	g	h	i	j

The framework is very specific about the fact that the levels are not to be compared to grades, or years. As they note, "it is entirely possible that one concept level may provide the content for two grades or a single grade or year might be devoted to more than one concept level."

c. AAAS Commission of Science Education

The AAAS makes recommendations for sequencing and relating content to specific grade level designations. Their schema for sequencing processes is indicated in the following distribution:

	Grades						
Processes	K	1	2	3	4	5	6
Observing	10	5	3	4			
Space/Time relations	6	6	3	3		1	
Classifying	3	3	2	3	2		
Using numbers	2	3	4	3	3	2	
Communicating	1	4	3	4	1		
Measuring	2	5	6	2	3		
Inferring			3	4	2		
Predicting			2	3	1	1	
Defining operationally					2	3	4
Controlling variables					7	5	3
Interpreting data					3	11	5
Formulating hypotheses					1	3	3
Formulating models					1	1	6
Experimenting					1	1	6

5. Teaching Strategies

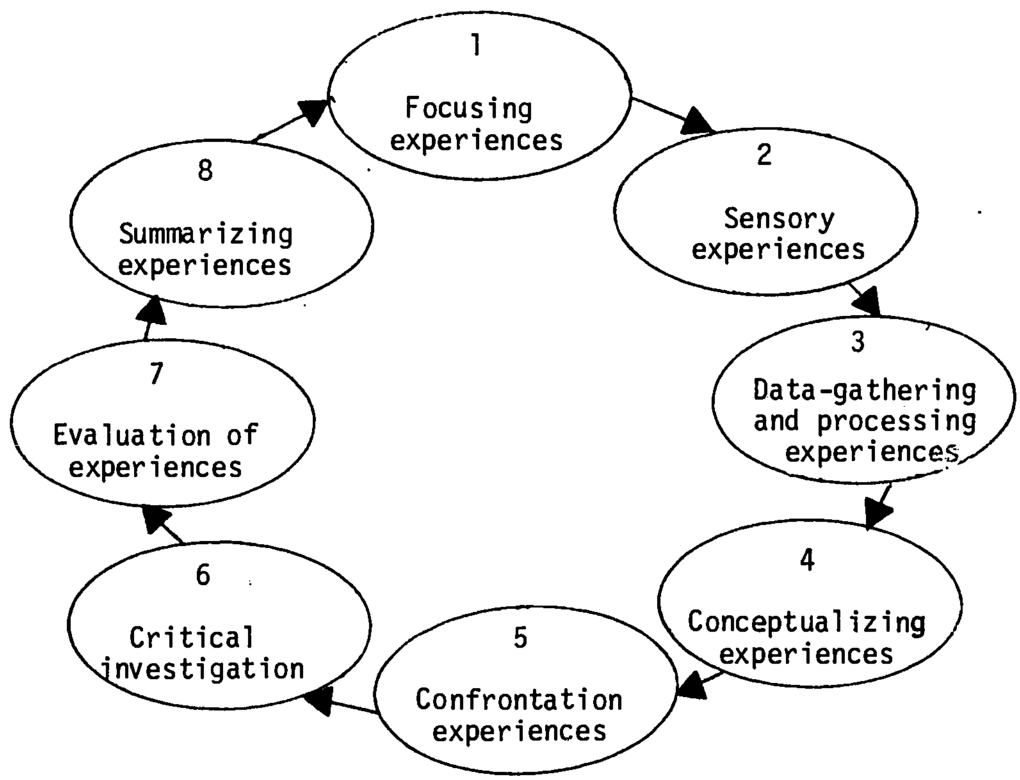
The most common teaching strategies in elementary school science are those which serve as models for scientific inquiry. The teaching strategy which provides the student with the opportunity to discover--to question, explore and investigate--seems to be the preferred strategy in the modern science program.

a. Guided Discovery Model*

This model includes the following processes: observation, exploration, demonstration, prediction, suggestion of experimental procedures, experimentation, recording data, drawing conclusions.

b. Concept and Process Developmental Model**

Another model for guiding discovery experiences includes the steps displayed below:



* Michaelis, John U.; Grossman, Ruth H.; Scott, Lloyd F., New Designs for Elementary Curriculum and Instruction, 2nd ed., New York: McGraw Hill and Co., 1975, p. 304.

**California State Department of Education, Science Framework for California Public Schools, K-12, 1970, p. 64.

B. PROSPECTIVE TEACHER TRAINEES

1. Preservice Preparation

   a. The preservice preparation of an elementary (K-6) science teacher displays the following configuration:

      (1) The general liberal arts requirements:

         (a) arts and humanities (6 credits)
         (b) communications (9 credits)
         (c) natural science (9 credits)
         (d) social and behavioral science (6 credits)

      (2) The professional education sequence is usually divided into two phases:

         (a) The first phase is devoted to the psychological, philosophical, and sociological foundations of education and "methods" courses. It might include "Teaching Science in the Elementary School" or "Elementary School Science" as well as methods courses in reading, mathematics, science, social studies, physical education, art and music.

         (b) The second phase is devoted to bridging the gap between theory and practice. This usually involves an initial field or practicum situation where the prospective teacher observes and assists a classroom teacher in planning and teaching the science class, and a semester of student teaching or internship experience.

   b. The preparation sequence for the junior high or middle school science teacher reflects a somewhat different configuration. The following description of the University of Florida's program for teaching earth science at the junior high level is an example of this configuration.

      The prospective teacher is required to take fewer methods or professional education courses and more science courses such as geology (28 quarter hours); meteorology (8 to 10 quarter hours); physics (6 to 10 quarter hours); and, chemistry (8 to 12 quarter hours). A middle school science certification at the same university requires 16 quarter hours of chemistry, biology, physics, and geology in addition to the science requirements associated with the liberal arts elements of the B.S. degree.

2. Competences for Teachers of Science

a. <u>Scientific Attitudes, Thinking Processes, Skills and Knowledge</u>

A science teacher should be able to do the following:

(1) Demonstrate recognition and recall of information selected as basic and indispensable in the field(s) of science.

(2) Pronounce correctly and define terms and phrases commonly used in his field(s) of science.

(3) State a number of major scientific concepts and demonstrate or explain their significance.

(4) List some significant or insoluble problems or paradoxes in science today and demonstrate or explain what makes them significant.

(5) Exhibit the scientific attitudes of open-mindedness and suspended judgment.

(6) Derive satisfaction and excitement from pursuing scientific investigations.

(7) Describe the interrelationships between various fields of scientific endeavor.

(8) Demonstrate proficiency in the manipulative skills of science.

(9) Perform mathematical calculations appropriate to his/her field(s).

(10) Present evidence of having carried through a piece of research and/or describe research done by someone else, indicating processes used and problems encountered.

(11) Identify and utilize the processes of experimentation, verification, analysis, synthesis, evaluation, hypothesis formation, and prediction when confronted with discrepant events in the environment.

b. Liberal Arts

A science teacher should be competent in the social sciences, the arts and humanities, and in the use of the English language. He/she must be able to:

(1) Use the skills and attitudes of the educated person in observing and interpreting the world.

(2) Interpret the present in terms of the past.

(3) Use the skills of oral and written communication effectively.

(4) Interpret the relationships between science and other aspects of human endeavor.

c. Instructional Methods and Techniques

Translating knowledge about how students learn into the specific instructional behaviors that will elicit the desired learning is the unique function of the teacher. He/she must be able to:

(1) Select materials and equipment that will lead to the learners' development of scientific attitudes, thinking processes, skills, and knowledge and be able to explain or justify these selections.

(2) Construct instruments of evaluation and follow other evaluative procedures to measure the learners' progress toward the stated objectives.

(3) Provide a rich environment of data sources, materials for experimentation, sources of ideas, phenomena to observe, and reference materials necessary for the development of scientific attitudes, thinking processes, skills, and knowledge.

(4) Use instructional time efficiently.

(5) Lead the students through a range of cognitive operations in arriving at a generalization inductively.

(6) Demonstrate ability to utilize psychologically sound techniques of reinforcement, transfer, and motivation.

(7) Formulate questions, design experiences, and select materials that will elicit in the students those cognitive processes identified in Bloom's Taxonomy.

(8) Make revisions of teaching strategies and classroom environment to make them more consistent with the nature of science, learning theories, or the learners' levels of development.

(9) Identify or construct situations that motivate inquiry in the learners.

(10) Use available data about each learner's conceptual level, cognitive style, interests, and abilities to process information from such data sources as the learner himself, parents, previous teachers, and the learner's cumulative record.

(11) Identify the growth of each learner toward autonomous inquiry, self-directed learning, self-evaluation, and increased interest in science.

d. Professional Education

The professional educator draws heavily on the disciplines of sociology, psychology, anthropology, and philosophy as a basis for deciding what to teach and for the methods of instruction. The professional educator is one who is well-grounded in these foundation areas and draws upon their theoretical constructs as bases for his behavior. He/she must be able to:

(1) Describe the social and cultural functions of the school.

(2) Explain the psychological bases for specific teaching techniques.

(3) Demonstrate observable attitudes of professional responsibility in personal behavior.

(4) Answer questions pertaining to the legal and financial operations of the school.

(5) Keep abreast of new developments in teaching and devise new techniques for effective teaching strategies in the light of new developments.

(6) Work with other staff members to improve curriculum and instructional practices.

(7) Relate and involve the work of the classroom with the community, thereby expanding the classroom and contributing to the community.

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PART SEVEN
CURRICULUM MODEL

The purpose of the Curriculum Model is to describe the various curriculum domains, consistent with the Behavioral Model, in which Natural Science environmental education teachers need to attain competence. The concepts displayed in this model are those deemed necessary for teachers to:

- acquire a holistic awareness and understanding of humanity-environment systems
- provide instructional arrangements which transmit this awareness and understanding to students

To accomplish these ends, two teacher competence domains and on teacher attitude domain have been identified which are as follows:

- Mastery of holistic environmental content
- Competence in managing instructional/learning arrangements
- Personal commitment to developing environmental awareness in students

A. MASTERY OF HOLISTIC ENVIRONMENTAL CONTENT

There are seven knowledge areas in which Natural Science teachers need to acquire competence in order to develop a holistic understanding of environmental curriculum content. These knowledge areas, which emphasize individual and societal levels of decision-making related to the use and conservation of environmental resources, would, if sufficiently elaborated, provide a basis for teachers to select and develop an environmental curriculum appropriate to their students.

The seven knowledge areas, described in more detail in the Environmental Education Content Specifications, are as follows:

1. Environment-related decisions made by the individual which orient the student to decision-making responsibilities affecting career choices and product consumption patterns that are associated with lifestyles.

2. Problem-solving and decision-making processes which can be applied to environmental problems and issues.

3. Analytical tools for understanding environmental systems which include general systems themes, fundamental concepts of energetics, and systems diagramming. These can be used to describe the relevant properties and interactions of humanity-environmental systems which operate within the biosphere.

4. Resource delivery systems which supply renewable and non-renewable resources to satisfy individual and societal needs. This covers the delivery system processes from exploration to end use, and the net energy "costs" of these processes.

5. Holistic lifestyle assessment which describes all the resources required to satisfy human needs in real energy terms. The assessment considers production and consumption activities that support existing individual and aggregate lifestyles.

6. Forecasting, planning, and policy formation which describes the highest levels of aggregate planning (e.g., multi-national, corporate, government) and its influences on lifestyles and the environment.

This area considers the idea of planned growth in business and government and explores the role of public utilities in resource delivery and utilization.

7. <u>Futures thinking</u> which examines combinations of careers, lifestyles, energy production and consumption, and their implications for the future s area addresses questions about future desires and t ty of present humanity-environmental systems to s these desires.

The degree of competence which a Natural Science teacher eventually achieves wit any given environmental knowledge area is expected to vary acco to the teacher's:

- subject matter specialty (e.g., chemistry, physics, biology-ecology, geology, etc.)
- degree of prior experience with environmental topics
- personal preferences or interests
- particular focus or point of view chosen for arranging and presenting an environmental education curriculum to students
- the needs and interests of the students

B. COMPETENCE IN MANAGING INSTRUCTIONAL/LEARNING ARRANGEMENTS

This domain characterizes four skill areas which teachers will utilize in developing their students' environmental awareness through an appropriate environmental curriculum content. (The skill areas described here will be more fully elaborated in the Environmental Education Curriculum Management Specifications.)

1. The first area deals with purposing an environmental education curriculum. This involves infusing environmental content into a Natural Science curriculum by:

   a. Setting student learning objectives which are compatible with both environmental curriculum content and the host curriculum.

   b. Assessing student learning objectives to ensure adequacy and relevance.

2. The second skill area deals with planning an effective environmental curriculum by selecting the content and setting the conditions under which learning will occur. This involves:

   a. Organizing the environmental subject matter and processes of the Content Specifications into a course learning trail.

   b. Developing useful contexts (e.g., maintaining fresh water ecosystem stability in northern California) which embody selected environmental principles, concepts, and factual data.

   c. Selecting appropriate instructional/learning arrangements for teaching the environmental content. In making such arrangements, the Natural Science teacher would consider:

      (1) discovery or directed teaching strategies

      (2) modes of inquiry

      (3) learning activities (e.g., case studies, field trips, interviews, demonstrations, role-plays, simulations, etc.)

(4) questioning strategies

(5) values analysis and clarification strategies

(6) entry points for introducing environmental topics to students

d. Organizing instructional/learning arrangements and resources into vertical (level of difficulty, complexity) and horizontal (over time) components.

e. Analyzing and allocating available resources which facilitate instructional/learning objectives.

3. The third skill area deals with implementing the environmental curriculum content by activating planned instructional/learning arrangements for achieving learning objectives. This involves:

   a. Applying planned instructional/learning arrangements organized into various types of learning experiences, i.e., focusing, data gathering, conceptualizing, confrontation, critical investigating, evaluating, or summarizing experiences.

   b. Utilizing appropriate resources for conveying environmental curriculum content, e.g., case studies field trips, demonstrations, simulations, etc.

   c. Utilizing problem-solving, and decision-making processes as a focus for exploring environmental curriculum content in classroom discussions, work assignments, and participation exercises.

4. The fourth skill area deals with evaluating the planned environmental curriculum content by assessing students' progress towards achieving specified competence objectives and making suitable adjustments in the instructional/learning strategies and arrangements to facilitate such progress. This involves:

   a. Developing strategies and instruments for carrying out formative and summative evaluation of learning and learning activities.

   b. Evaluating all areas of the environmental teaching/learning context including the curriculum content, the instructional/learning arrangements for conveying the content, and the evaluation procedures and instruments for assessing students' progress in achieving learning objectives.

c. Making any necessary modifications or revisions in (1) the training strategies, tactics, or materials, and/or (2) the environmental awareness learning objectives.

The degree of teacher competence achieved within any given management skill component is expected to vary according to the degree of training and experience which the Natural Science teacher (or curriculum developer) has in carrying out the activities indicated for purposing, planning, implementing, and evaluating.

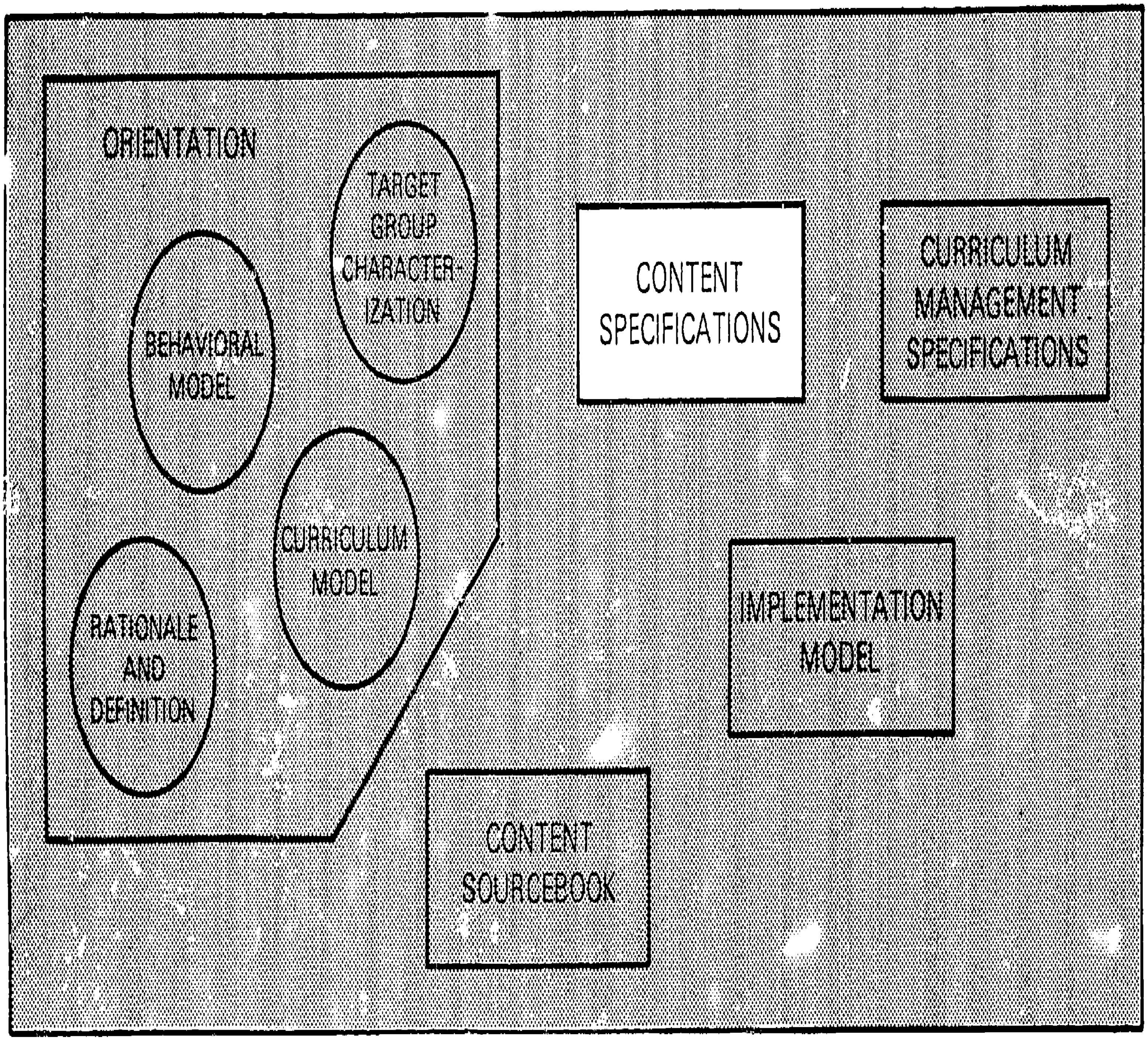
C. PERSONAL COMMITMENT TO DEVELOPING ENVIRONMENTAL AWARENESS IN STUDENTS

Commitment to developing environmental awareness in students should begin to emerge as Natural Science teachers gradually acquire an understanding of the holistic environmental content and develop or exercise competence in devising and implementing instructional/learning arrangements which transmit this content to their students.

The process of developing committed personal behavior, therefore, is expected to occur as Natural Science teachers immerse themselves in the holistic environmental content and the management strategies for conveying the content to students, and seek to integrate these two elements within the framework of their professional classroom behavior.

Content Specifications

THE NATURAL SCIENCE ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL



ENVIRONMENTAL EDUCATION
TEACHER TRAINING MODEL

TABLE OF CONTENTS

INTRODUCTION

The human eye is designed to focus upon one and only one distinct point within a field of vision at a particular time. While we remain aware of surrounding stimuli, the clarity of vision always falls upon only one point. Such a vast distortion might be considered a liability were we not endowed with a reflecting mind with which to place this focal point within a space-time context. This "envelope of awareness" is a source of organizing our understanding about ourselves and about the world.

When examining as broad a concept as Environmental Education, it is important to understand the significance of our modes of inquiry as well as to examine their limits. We are given a specific set of tools in each of the Natural and the Social Sciences which offers us a valuable means of explaining and understanding certain phenomena. Through generally deductive modes, we arrive at a kind of model of "reality" within a universe which demands broader modes of explanation. We often find our explanations falling short so we resort to generalizing about the nature of things and of human beings. In other words, we tend, like the focusing eye, to automatically induce distortion as we focus too tightly on one explanation. This "distortion" of the world is not in and of itself necessarily undesirable.

The problems arise as we view it exclusively as the <u>only</u> mode of analyzing what is "out there." So, in understanding the world, we are constantly challenged to expand our perceptual maps into wider and wider spheres of ambiguity.

Environmental Education is, by nature, transdisciplinary. At the heart of the ecological perspective is the realization that human/environmental systems cannot be comprehended by studying their isolated fragments.

> "Subduing and subdividing it into easily manageable units only destroys its most important features, the processes of interaction which make it attractive and functional. Rather than simplifying our subject matter, we must learn to complexify our means for comprehending it. Genuine environmental scholarship will have to emphasize the understanding of processes above the measurement of entities. Environmental Studies should be structured as ecosystems are, recognizing complex interdependencies and accepting competition, contradiction, and uncertainty as necessary conditions for learning. Their goal should be the encouragement of wisdom and good judgement, leaving the task of filling our information cribs to the academic [specialists].[1]"

The traditional pursuit of knowledge via academic disciplines is useful only insofar as one locates its parameters within a much greater whole. Organism and environment are mutually co-defined systems; neither is whole without the other. Yet an organism is isolated from its environment for purposes of study. A temporary discrimination is made enabling the disciplinary eye to focus upon its object of interest while the investigator hopefully remains aware that it cannot be totally removed from its environmental context. Organism and context are one. In the language of philosophy, we are making a distinction between things that belong to the world only to be able to utimately dissolve that artificial distinction.

In order to become manifest, "content" demands "form" for its proper expression. Although the following model for Environmental Education

[1]Meeker, Joseph W., "Academic Fields and Other Polluted Environments," The Journal of Environmental Education, Volume 4, Number 3, Spring, 1973, page 38.

is generic, existing Natural and Social Science programs provide a valuable vehicle for infusing these holistic concepts and process skills into modern education.

The Content Model outlined on the following pages is oriented toward providing the learner with a systemic conceptual and operational basis for understanding environmental systems as related to:

- the individual decision maker
- public decisions

The content system emphasizes both the societal and individual dimensions of decision-making and their interrelationships; it identifies how these decisions can be made and interpreted from various worldviews. The use and conservation of environmental resources is approached from both the production and consumption points of view as it relates to both the individual and society.

Figure 1 specifies the components of the Content Model and their linkages. These represent an ordered flow of concepts that build the complex configuration for comprehensive environmental education as necessary to informed decision-making.

Detailed specifications for each of the components of the model are presented in the text. These "knowledge components" are followed by a description of the instructional focus and "purpose" of the section. Following these specifications are selected references which could be utilized in developing these components into instructional/learning resources.

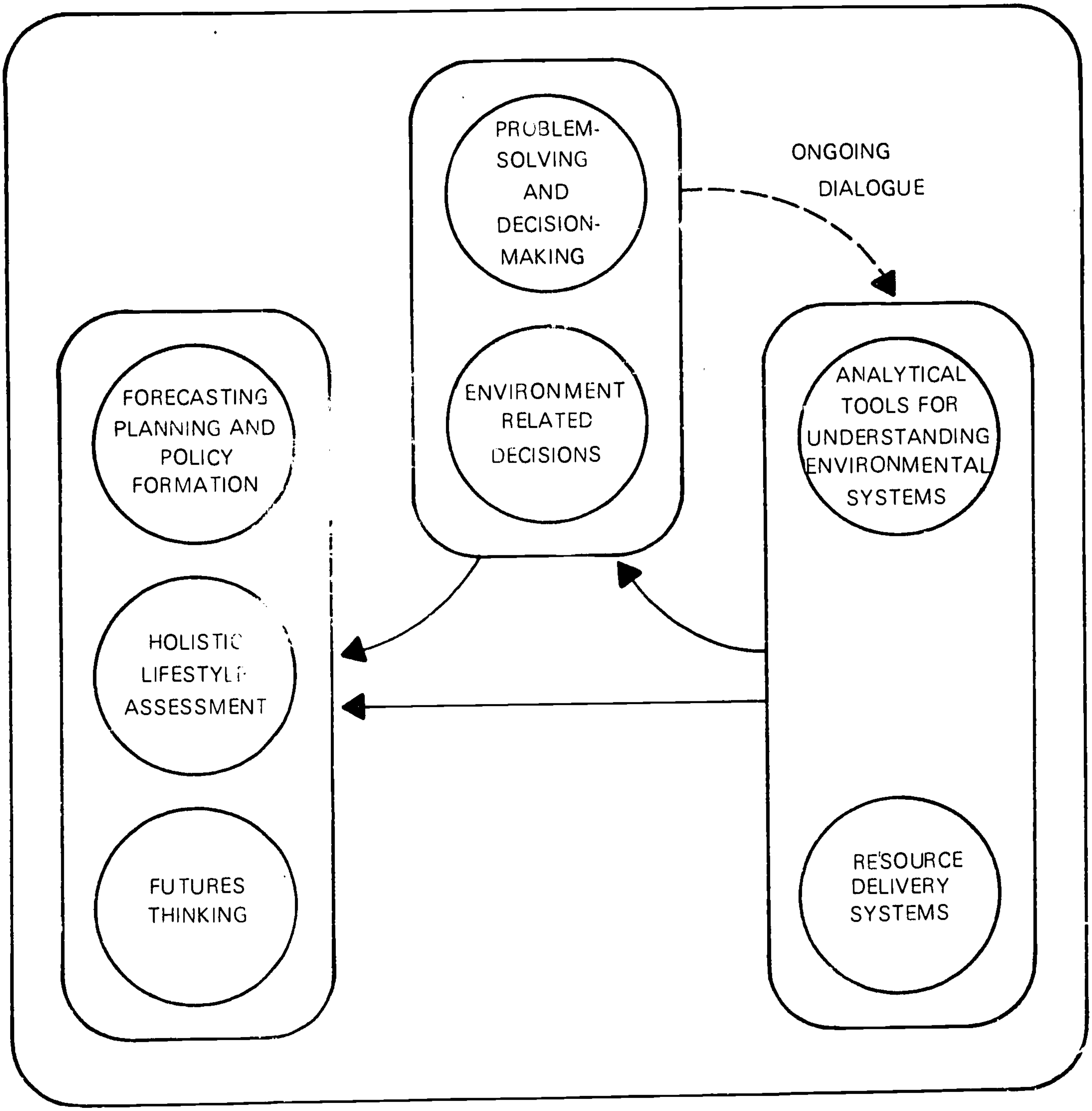
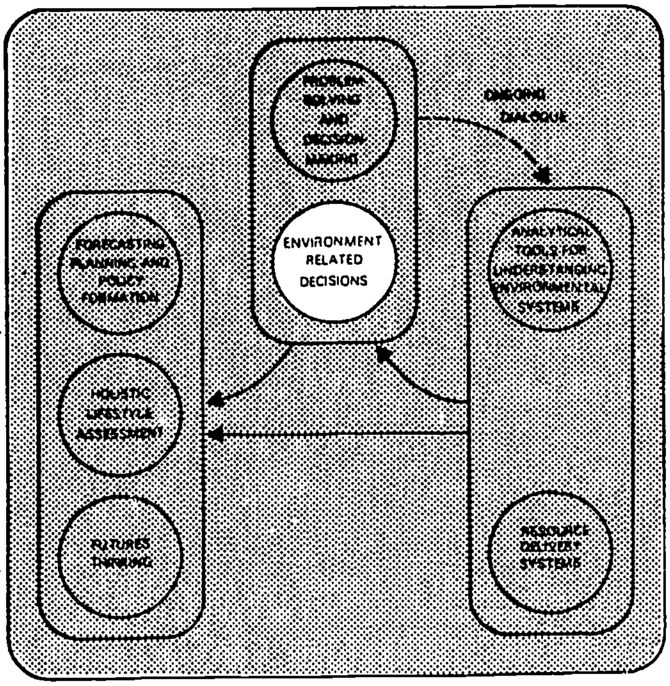


FIGURE 1.

CONTENT MODEL FOR ENVIRONMENTAL EDUCATION

4/5

ENVIRONMENT-RELATED DECISIONS



CONTENT MODEL FOR ENVIRONMENTAL EDUCATION

ENVIRONMENT-RELATED DECISIONS focuses on the student as a person with decision-making responsiblities in two major areas: career choice and product consumption patterns that are associated with lifestyles.

1. Career Choices

2. Lifestyle Consumption Patterns

Knowledge Components of ENVIRONMENT-RELATED DECISIONS

This area of the curriculum will explore decisions affecting an inaividual's career choice as well as the resource consumption pattern of the chosen life-style.

6/7

1. CAREER CHOICES

A variety of job opportunities can be classified according to their environmental implications.[1]

- Are they directly or indirectly related to the use of environmental resources?
- Are they directly or indirectly related to policy and fiscal procedures that account for many aspects of environmental utilization?[2]
- Are they directly or indirectly related to the information organizing institutions that service the above?

2. LIFESTYLE CONSUMPTION PATTERNS

The individual's chosen lifestyle within society requires that certain defined "needs" are satisfied.[3]

- What is the environmental "cost" of satisfying these needs?[4]
- What are the implied "costs" of a "successful future" associated with the chosen lifestyle consumption pattern?

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[1] Since this covers a wide range of career possibilities, a comprehensive understanding of the environment is needed.

[2] See RESOURCE DELIVERY SYSTEM stages for a description of production processes.

[3] See HOLISTIC LIFESTYLE ASSESSMENT for a list of these human needs.

[4] See RESOURCE DELIVERY SYSTEMS for a discussion of environmental "cost accounting."

The $\boxed{\text{purpose}}$ of the knowledge components of ENVIRONMENT-RELATED DECISIONS is:

1. To set the stage for later discussions (in FUTURES THINKING) involving the students' choice of life-style and career.

2. To establish a framework for describing how environmental systems are related to each of our lives (see HOLISTIC LIFESTYLE ASSESSMENT and RESOURCE-DELIVERY SYSTEMS).

ENVIRONMENT-RELATED DECISIONS

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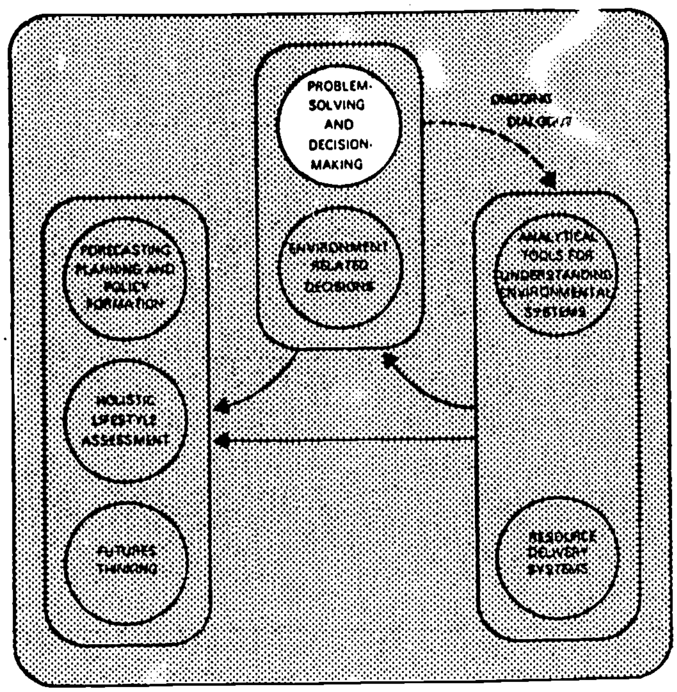
PROBLEM SOLVING AND DECISION-MAKING



CONTENT MODEL FOR ENVIRONMENTAL EDUCATION

1. Problem-solving
2. A Complex Decision-making Model

Knowledge Components of
PROBLEM-SOLVING AND DECISION-MAKING

Environmental problems and issues, whether on the individual or the aggregate level of society, require a systemic approach for appropriate and effective resolution of the problem.

A PROBLEM-SOLVING approach has a well-defined goal; a problem is identified and the process of solving it can be either linear or complex.

A DECISION-MAKING process requires a comprehensive overview of the "problem components." The linear steps of problem-solving are incorporated into a complex model which depicts the input and output flow of the various "problem or decision components." A model of this complex decision-making process is presented in this section.

This area of the curriculum will describe some major problem-solving routines. It will also present a model for complex decision-making.

1. PROBLEM-SOLVING

The problem-solving quest is established by the interaction of two sets of variables:

- the constraints imposed by the nature of the solution sought
- the nature and/or posture of the problem-solver

The combination of these two aspects determines a routine for questing. Four major routines for problem-solving are:

a. artistic--search for form

b. craft--search for style/tradition

c. technological--search for methods and valid routines

d. paradigmatic--search for verities and constancy

These routines all have three limitations in common: media, tools and protocols. They may be utilized singularly or in combinations, depending upon the nature of the problem and the creativity of the problem solver.

2. A COMPLEX DECISION-MAKING MODEL

a. Requirements for a complex decision-making model

(1) Based on systemic, holistic methods for dealing with complex environmental issues

(2) Utilize data organizational tools which enhance human perception

(3) Provide the basis for the disciplined development of new knowledge and new, more comprehensive and integrative strategies

(4) Have the ability to adapt and change itself

(5) Enable the users to explore and mediate conflicting dimensions of public/private, individual/social, natural/man-made systems

(6) Recognize the utility of intuitive methods in addition to rational, scientific means

(7) Generate a variety of implementation strategies

(8) Generate appropriate decision criteria for evaluating alternative solutions

(9) Enable the users to explicate value components of the decision process

b. The components of a complex decision-making model are:

(1) A perception of a need for change

(2) Acquisition of relevant data or information

(3) Prediction of the behavior of the system under consideration

(4) Articulation of relevant individual/social value systems

(5) Generation of futures-oriented alternatives

(6) Development of decision criteria

(7) Recommendation or choice of outcomes or actions; verification of hypotheses

(8) Implementation of recommended or chosen outcomes or actions; addition to or expansion of general state of knowledge

(9) Monitoring of effects, functions, or activities.

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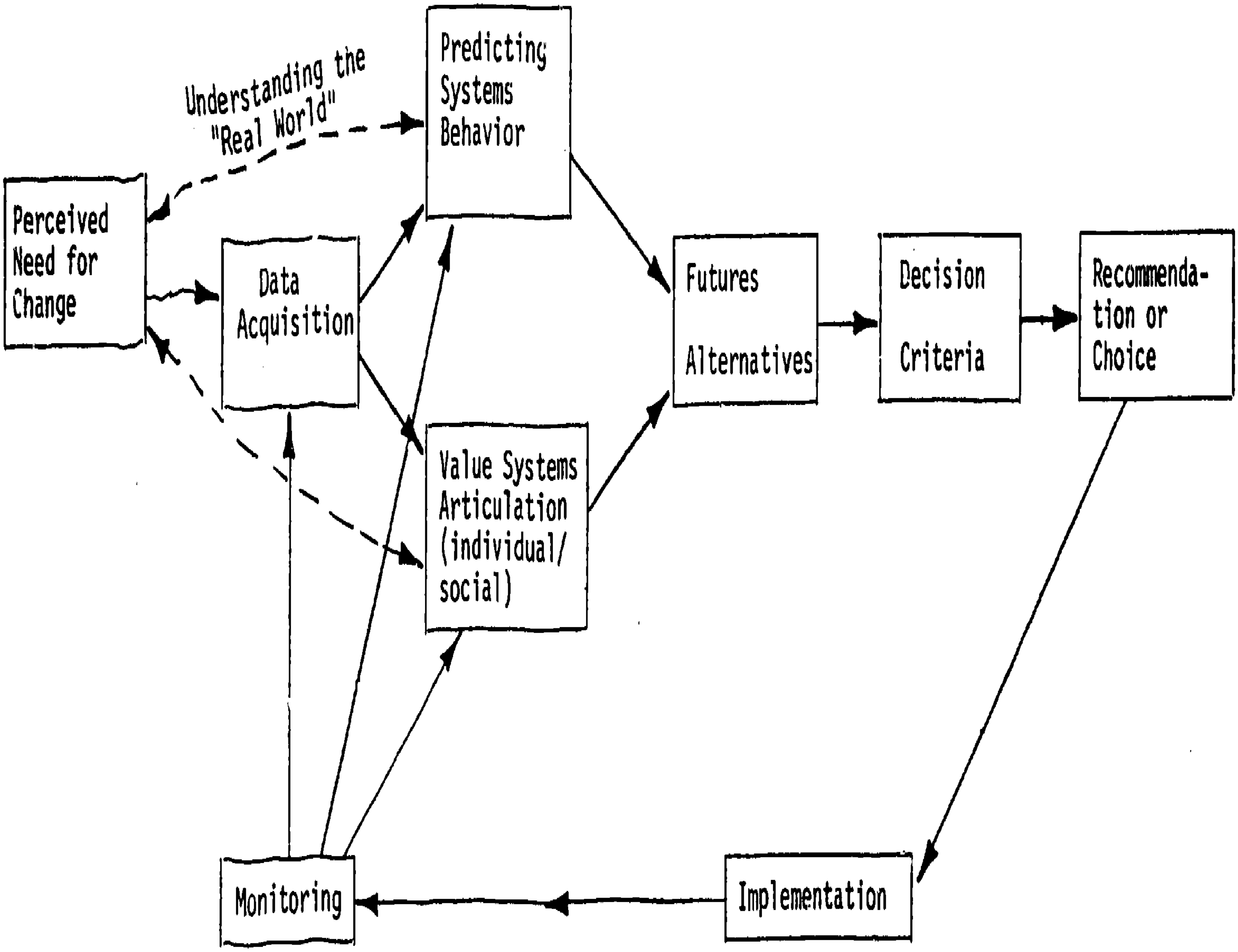

A GENERIC COMPLEX DECISION-MAKING MODEL

The $\boxed{\text{purpose}}$ of t'ie knowledge components of PROBLEM-SOLVING and DECISION-MAKING is:

1. To introduce some problem-solving routines.

2. ,o introduce a generic complex decision-making strategy.

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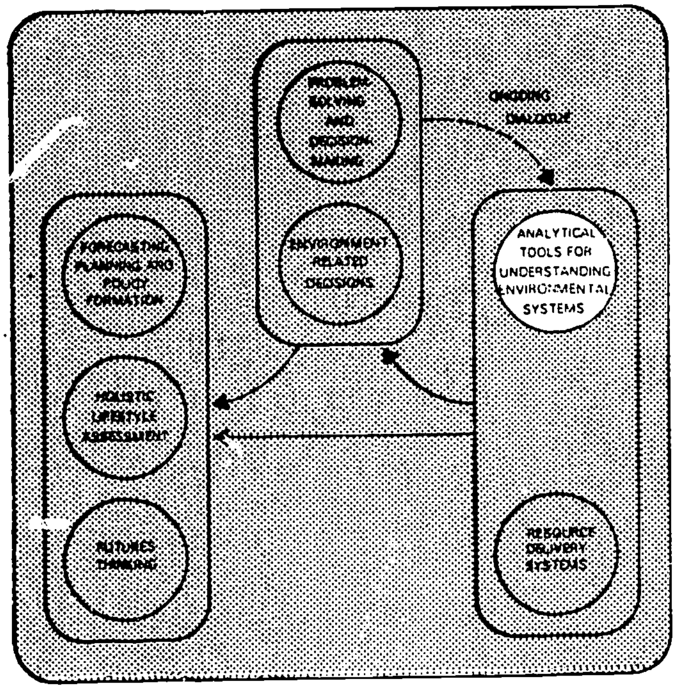
ANALYTICAL TOOLS FOR UNDERSTANDING ENVIRONMENTAL SYSTEMS



CONTENT MODEL FOR ENVIRONMENTAL EDUCATION

A systemic approach to learning about environmental systems implies the development of a holistic understanding of the components and the interactions among the components. Certain ANALYTICAL TOOLS are helpful in depicting and describing environmental systems.

1. General Systems Themes
2. Fundamental Concepts of Energetics
3. Systems Diagramming

Knowledge Components of ANALYTICAL TOOLS FOR UNDERSTANDING ENVIRONMENTAL SYSTEMS

This area of the curriculum presents tools that are useful in recognizing and describing patterns of systems and systems behavior. These principles of energetics are presented as being useful in understanding general systems behavior.

1. GENERAL SYSTEMS THEMES

Certain principles of systems and systems behavior are prevalent when "treating sets of related events collectively as systems manifesting functions and properties on the specific level of the whole."[1]

The following are some General Systems Themes which are described in more detail in the Content Sourcebook.

- Definition of System introduces various types of energy systems and examines three systems properties: boundaries, entities and input/output.
- Interactions describes three types of systems interactions: coupling, linkage and interrelationships.
- Cycles includes the dimension of time or periodicity in the consideration of both life cycles and periodic cycles.
- Feedback defines the role of feedback in terms of the growth or control of a system. It emphasizes the balance of negative and positive feedback.
- States of Equilibrium identifies durations and degrees of stability and instability in systems.
- Hierarchy provides parameters for identifying patterns of hierarchy in natural and man-made systems.
- Systemic Energy Flow discusses three types of energy flow: ordering, disordering and synergistic.
- Systemic Evolution unifies the structure of a system and its processes in the dynamic quest for self-renewal and self-expression.

[1] Engel, George L., "The Need for a New Medical Model: A Challenge for Biomedicine," Science, 196:4286, April 8, 1977, 129-135.

2. FUNDAMENTAL CONCEPTS OF ENERGETICS

a. Law of conservation of energy: energy is neither created nor destroyed.

> "The energy entering a system must be accounted for either as being stored there or a flowing out."[2]

b. Law of degradation of energy: any process must degrade some of its energy.

> "In all processes some of the energy loses its ability to do work and is degraded in quality."[3]

Energy that has the ability to do work is called potential energy and is useful. Energy that has done work is degraded and is no longer useful at its original potential.

c. The maximum power principle explains why certain systems survive.

> "That system survives which gets most energy and uses energy most effectively in competition with other systems."[4]

To "get more energy" or develop more power inflow, a system might:

- develop storages of high-quality energy
- use storages to increase energy flow (feedback)
- use storages as a control mechanism to keep the system stable: inflows balance outflows
- recycle materials as needed

The application of this principle to new systems developing in an environment of abundant resources (early succession) generates competition. The application of this principle to mature systems that are in steady state with the resources of their environment (climax) generates cooperation.

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[2]Odum, Howard T. and Odum, Elisabeth C., Energy Basis for Man and Nature, New York: McGraw-Hill Book Co., 1976.

[3]Ibid, p. 38.

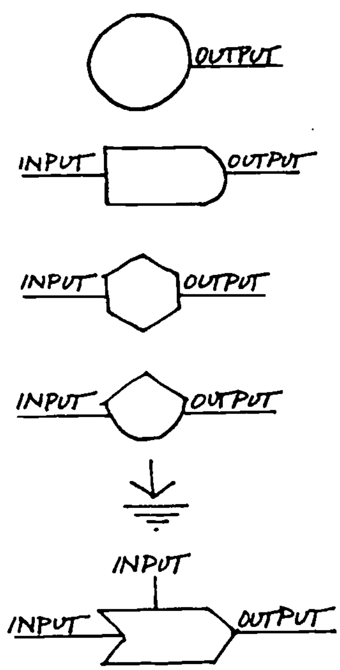
[4]Ibid, p. 39.

3. SYSTEMS DIAGRAMMING

A set of simple diagrammatic symbols can be used as a means to visualize the behavior of whole resource systems. A diagram made up of such symbols can clearly map the interactions of resources and energy flows of a real system.

A set of symbols has been developed by H. T. Odum for diagramming the interactions of man and nature.[5] These symbols are based on the most common entities and activities found in all systems that process resources and utilize energy.

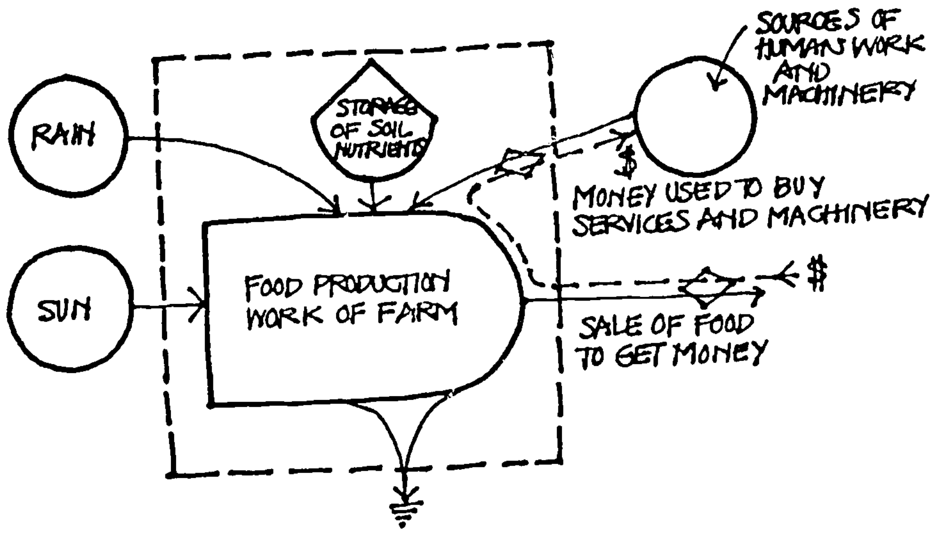
The symbols are representative of the following energy processes:



- sources of resources and/or energy
- production subsystem or photo-synthesis activities
- consumer subsystem
- storages
- energy sinks
- interaction of energies flowing along pathways

[5]Odum, Howard T., and Odum, Elisabeth C., Energy Basis for Man and Nature, New York: McGraw-Hill Book Co., 1976, pp. 269-70.

Using these symbols, some processes of a typical farm system can be shown as follows:



The $\boxed{\text{purpose}}$ of the knowledge components of ANALYTICAL TOOLS FOR UNDERSTANDING ENVIRONMENTAL SYSTEMS is:

1. To relate real world phenomena to a simple, graphic diagrammatic language which provides a necessary step to performing conceptual analysis of systems interactions.
2. To demonstrate that the environment, though complex, can be understood.
3. To counteract the attitude that in the face of complexity simplistic views are acceptable.
4. To introduce a set of transdisciplinary symbols which can be used to describe humanity-environment interactions.
5. To demonstrate how fundamental energy concepts can be used as a tool for understanding environmental systems in a holistic and integrated way.
6. To demonstrate how an understanding of systems can be used to describe and understand many types of environmental phenomena.

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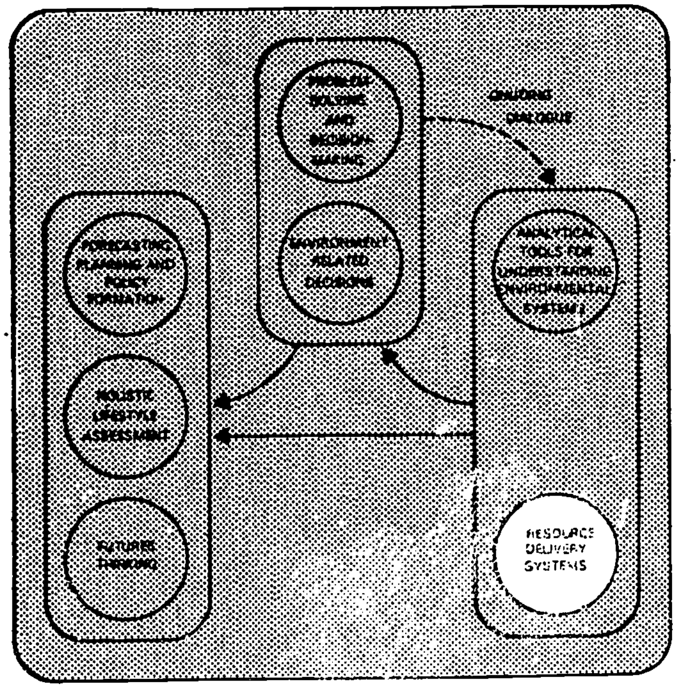
RESOURCE DELIVERY SYSTEMS



CONTENT MODEL FOR ENVIRONMENTAL EDUCATION

RESOURCE DELIVERY SYSTEMS are the means to satisfy the demands of society. From exploration to end use, the many processes of the delivery system have environmental "costs."

Since energy resources are required to utilize other resources, many of these environmental "costs" are measured in terms of energy; others are not, such as environmental impact reports and increasing pollution levels. The traditional cost-benefit analysis weighs all of these "costs" to deliver the resource against the benefits received from the utilization of the resource.

1. Resources
2. Delivery Systems Stages
3. Net Energy Analysis
4. End Use

Knowledge Components of RESOURCE DELIVERY SYSTEMS

This area of the curriculum will explore several aspects of resource delivery systems as they relate to our individual/aggregate life-style decisions.

1. RESOURCES

a. The primary resources available to humanity are of two main types:

(1) Non-renewable: a quantity of finite reserves that are made available to society as a function of available technology and capital investment.[1]

(2) Renewable: infinite reserves are available at specific rates to humanity depending upon specific locale; their availability as a resource is also a function of available technology and capital investment.

NON-RENEWABLE RESOURCES	RENEWABLE RESOURCES
Fossil Fuels	Water
Mineral Resources	Solar, Geothermal energy
Physical Space	Food and fiber crops
	Forests
	Fisheries

b. There are some secondary or tertiary sources of resources which can be classified as recyclable from processes that utilized either type of primary resource. Re-using degraded steam from an electric turbine for heating or burning an industrial waste to make useable steam is an example of cogenerating systems.[2] There are many ways to couple cogenerating systems to increase overall efficiency of primary resource use.

[1] Lovins, Amory, "Energy Strategy: The Road Not Taken," Foreign Affairs, Vol. 55, No. 1, October, 1976, pp. 65-96.

[2] Business Week, "Saving Energy the Cogeneration Way," June 6, 1977, p. 99.

2. DELIVERY SYSTEMS STAGES

The general organization of resource delivery systems has eight stages from primary resource site to end use:

STAGE	SAMPLE RESOURCE DELIVERY SYSTEMS	
	NON-RENEWABLE	RENEWABLE
	OIL TO ELECTRICITY	WHEAT TO BREAD
1. EXPLORATION: siting of resource deposits, basic research and development of exploratory techniques, machinery	Geologic exploration for oil	Agricultural chemists's search for improved method of wheat production
2. EXTRACTION: removing the resource, machinery and site equipment, materials, operating agencies, maintenance over the life of the site	Tapping oil well	Harvesting wheat
3. TRANSPORT I: transportation mechanisms and operating energy necessary to carry the resource to the next facility	Shipment of crude oil	Trucking of grain
4. PROCESSING: energy to run machinery, construction of the facility, its maintenance and operating energies	Processing of crude oil	Grinding of grain
5. TRANSPORT II: transportation systems and the operating energies required to move the resource to the conversion plant	Shipment of partially refined oil to a regional refinery	Trucking of flour to baker
6. CONVERSION: plant construction, materials and maintenance	Transformation of oil into electricity	Transformation of dough into bread
7. DISTRIBUTION: energy costs, equipment, storage facilities and networks to move the converted product from final facility to point of consumption	Sale of electricity to a household	Sale of bread at grocery store
8. END USE: Input to the "basic human needs" system	Operate electric toaster	Eat the bread

3. NET ENERGY ANALYSIS

Net energy analysis is an accounting technique which determines in terms of energy, the amount of a resource remaining for use after all the "costs" to make it available have been "paid" in energy equivalents.[3]

The three principles of energetics (see FUNDAMENTAL CONCEPTS OF ENERGETICS) are used to account for energy losses during the resource delivery system processes.

Three types of resource losses are:

a. Degradation: the premature degradation of resources such as gasoline losing potency, batteries losing charge, timber rotting, food and fiber spoiling, soil depletion.

b. Physical: spillage during transport and processing such as an oil spill or discarding a resource that is inadequate and/or overly contaminated such as low grade ore, high-sulfur coal, or overripe food.

c. Internal Use: a fraction of the resource being supplied is diverted and fed back into the operation of the same system such as using generated electricity to light the generating site, or using timber shavings from a mill in a steam plant to run the mill. This type of loss is a good candidate for recycling or cogeneration applications.

[3] Odum, Howard T. and Odum, Elisabeth, Energy Basis for Man and Nature, New York: McGraw-Hill Book Co., 1976.

4. END USE

End use is the consumption of resource products. It is the process which satisfies the basic human needs described in HOLISTIC LIFE-STYLE ASSESSMENT.

These "resource products" are of two types:

a. Direct: consumables such as fuels, petro-chemical feedstocks, electricity, foodstuffs, toiletries, and disposable plastics such as styrofoam cups.

b. Indirect: all other energy forms that are required in the delivery systems to make the direct resource products available. This includes the energy necessary to construct and maintain the delivery systems processes.

> The "cost" of any product reflects the sum of the direct and indirect energies and resources involved to make it available to the consumer.

The purpose of the knowledge components of RESOURCE DELIVERY SYSTEMS is:

1. To describe renewable and non-renewable resources.

2. To indicate the methods and means by which products and materials are supplied to satisfy the aggregate lifestyles of society.

3. To describe a generic resource delivery system from exploration to end use.

4. To describe types of energy and resource "losses" during the delivery system processes.

5. To introduce a guideline for assessing the appropriateness of energy resource products and uses.

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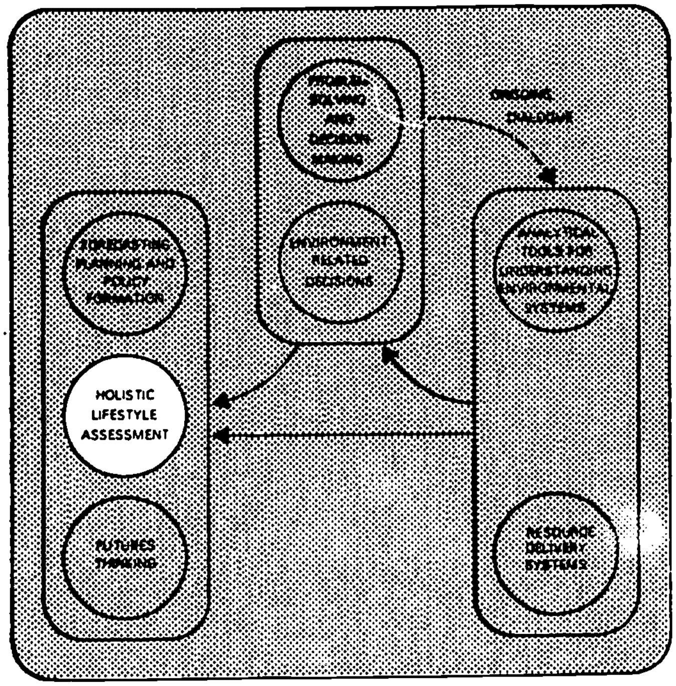
HOLISTIC LIFESTYLE ASSESSMENT



CONTENT MODEL FOR ENVIRONMENTAL EDUCATION

The process of HOLISTIC LIFESTYLE ASSESSMENT describes all the resources required to satisfy basic human needs in real resource terms. The assessment is a delineation of the inputs, throughputs and outputs[1] of resources and resource products that support an existing lifestyle.

It considers the energy relationships of all actions and events broadly classified according to the individual's (or society's) production and consumption activities.

1. The Human System
2. Aggregate Lifestyle Assessment

This area of the curriculum will describe the human system, its needs, and the impact of aggregate lifestyles on our environmental resources.

[1] Inputs, throughputs, and outputs are the main classifications of a systems flow of energies, materials and information. Inputs are the necessary sources, or driving functions of the system; throughputs are the system's activities of processing, transforming, storing and converting; and outputs constitute the goods, services and information "exported" as products from the system.

1. THE HUMAN SYSTEM

a. Define the individual as an <u>open</u> system with:

(1) Inputs: fresh food, fresh air, fresh water, and also fuels, shelter and clothing

(2) Throughputs: system processing of food, air, water; use or depreciation of fuels, shelter, clothing

(3) Outputs

(a) Waste - trash, garbage, sewage, noise

(b) Meaningful work, maintenance work.

(c) Creative activity

b. Human needs upon which resources are spent.[2]

NEED	MEANS OF SATISFACTION
Residential Shelter	Furniture, Lighting, Appliances, Heating, Cooling, Water Supply, Landscaping
Organizations	Government, Political, Financial, Labor, Service, Special Interest Groups, Professional, Social, Legal
Creativity and Recreation	Sports, Entertainment, Toys, Pets, Arts and Crafts, Alcohol and Drugs
Food	Meats, Vegetables, Dairy, Fruits, Grains, Bakeries
Communications	Telephone, Radio, TV, Books, Talk, Magazines, Postal
Physical Protection	Police, Fire, Military, Health
Apparel and Grooming	Cosmetics, Clothing, Hair Care
Curiosity and Knowledge	Schools, Libraries, Museums Galleries
Spiritual	Churches
Birth and Death	Maternity, Babywear, Funeral Parlors
Mobility	Cars, Buses, Airplanes, Highways

[2]Adapted from Governor's Task Force on Energy, Oregon's Energy Perspective, State of Oregon, 1973.

(1) Certain of these human needs are "climate specific" or related to the individual's surrounding natural environment. Varying natural environmental contexts have different characteristics which generate and provide for some human needs. One important characteristic is climate.

- Macro-climates are associated with the major geographic regions such as mountains, deserts, major plains, and coastal areas.

- Micro-climates are smaller scale variations associated with special variations in the local area such as: river beds, forests, foothills and beaches.

These "climate specific" needs are closely linked to the physical environment and are usually satisfied sequentially.

(2) Other human needs are "cultural-environmental" specific, or related to the individual's understanding of his/her cultural environment. Two levels of cultural environments can be described:

- Macro-cultural environments include ethnic group stereotypes, sub-culture identification, religious affiliation, etc.

- Micro-cultural environments include urban or rural, old established family or tourist, socio-economic level, etc.

The interplay of these two levels generates very complex value systems in the individual. And when this interplay is combined with an individual's migration and exposure to all-pervasive media, it renders a distinct articulation of values very difficult.

(3) An individual's attitudes and values can be defined as a "fuzzy set" system or WORLDVIEW consisting of:

- Inputs in the form of cultural heritage, customs, and social norms through early childhood and family interaction.

- Current attitudes and values development reinforced through cultural peer interaction.

- Maintenance and continuance of accepted worldview through present decisions to satisfy future desires; these decisions establish the inertia of an individual's personal performance in career and lifestyle.

2. AGGREGATE LIFESTYLE ASSESSMENT

The combined needs of different individual lifestyles have varying impacts upon both the surrounding natural environment and the cultural environment.

The impact of aggregate lifestyles upon our resources may:

- be within the environment's limits of tolerance
- exceed the environment's limits of tolerance

In the latter case, additional energies will be required to return the environment to its previous configuration. The additional energies can be provided by the individual or by society.

The $\boxed{\text{purpose}}$ of the knowledge components of HOLISTIC LIFESTYLE ASSESSMENT is:

1. To identify the inputs, throughputs and outputs of a human system in real resource terms.

2. To delineate the human needs which require resource expenditure.

3. To recognize the impact of aggregate lifestyles on the environment.

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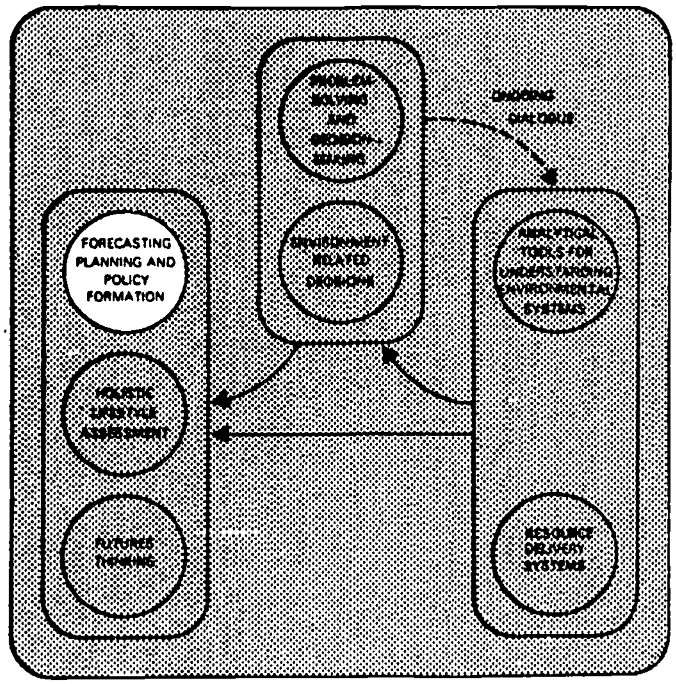
FORECASTING, PLANNING AND POLICY FORMATION



CONTENT MODEL FOR ENVIRONMENTAL EDUCATION

FORECASTS and trends play an important role in planning and policy formation/evaluation.

Forecasts are generated from available data and are based on certain assumptions regarding population, government, weather, etc. Trends are also mapped from available data, but are usually of a more general nature.

PLANNING AND POLICY FORMATION takes into consideration these forecasts and trends, but does not necessarily use them. The planners might challenge the assumptions on which they're based. Or they may use the forecast, but monitor it to verify its accuracy.

Forecasts which prove valid confirm plans or policies and act as reinforcements to continue in the same direction. Forecasts which result in contradictions serve as an error message and may change the direction of the planning.

1. Growth Management
2. Public Utilities

Knowledge Components of FORECASTING, PLANNING AND POLICY FORMATION

This area of the curriculum will describe the idea of growth management in business and government and will explore as an illustrative example the role of public utilities in energy delivery.

1. GROWTH MANAGEMENT

Aggregate consumer decisions form part of the data base from which projected patterns, or forecasts, are extrapolated. These patterns establish the basis for growth management (kind, quality, amount of growth).

The goals of our institutions have historically been short term (less than 10 years) and as situations worsen and available data become more unreliable they become shorter (less than 1 year). The time horizon of goals greatly affects growth management strategies.

The following institutions are engaged in growth management:

- private business: financial planning, capital formation
- government: legislation and regulations affecting business and affecting the public interest

Consider: anti-trust laws, tariffs, subsidies, public utilities commissions, recreation and wildlife areas management

opinion polls, marketing research and advertising

2. PUBLIC UTILITIES

Public utilities provide for a large share of an individual's (or society's) basic needs: fresh water, natural gas, electricity, transportation, and communications. In terms of the individual as a system these utilities are inputs and depend upon energy delivery systems for their continual operation and availability.

The relationships among policy regulations, financing capital investment and physical construction of energy delivery systems can be examined by looking at:

- How energy-based forecasting is a basis for utilities planning and construction
- The function of the State Public Utility Commissions
- Types of rate structures

Consider: Current practices.

Lifeline allowances where a basic allowance for the household is calculated based on size of household unit, number of occupants, etc., and an allowance is fixed. If consumption exceeds the allowance, another higher rate is charged for the excess.

Exponential where the more energy you use, the more you are charged per unit.

Inverted where the more energy you use, the less you are charged per unit.

Incremental where the rate increases by steps (0-100 at Rate 1, 100-1000 at Rate 2, etc.)

Credit Accruing where you may be generating more energy than you are using, thereby accumulating credit.

Time dependent where the cost per unit varies with the time of use (day or night, peak or off hours).

The $\boxed{\text{purpose}}$ of the knowledge components of FORECASTING, PLANNING, AND POLICY FORMATION is:

1. To recognize that individual consumer decisions are a basis for government and corporate planning.

2. To demonstrate the relationship between constructing energy delivery systems and corporate/utility planning and policy formation.

3. To examine the impact of this forecasting/planning on individual lifestyle choices.

FORECASTING, PLANNING AND POLICY FORMATION

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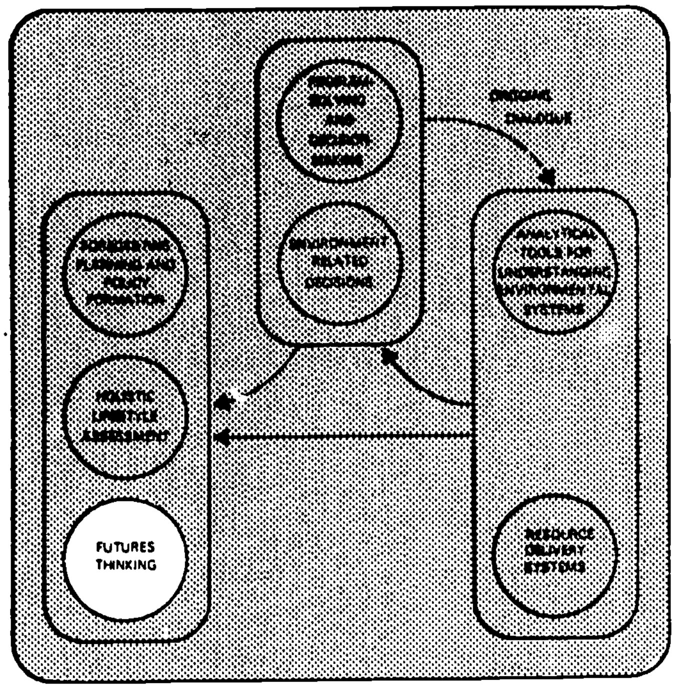
FUTURES THINKING

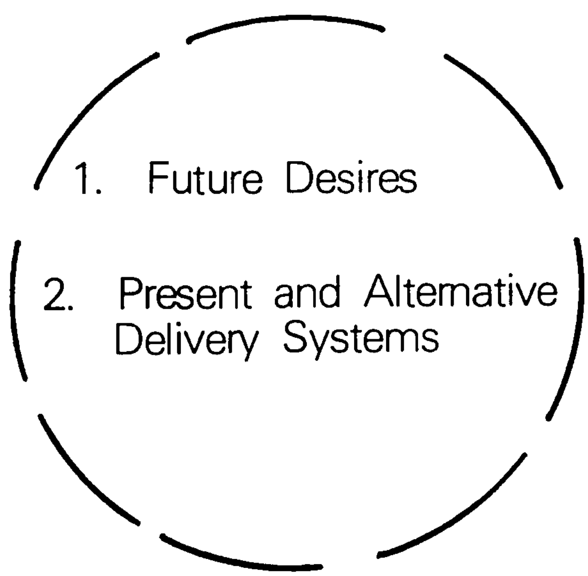


CONTENT MODEL FOR ENVIRONMENTAL EDUCATION

FUTURES THINKING examines the relationship between "futures" and the limitations placed on imagination by people and institutions. The nature of these limitations separate possible futures from probable futures.

Values and LIFESTYLES play a definite role in futures thinking as resources (human, material, and currency) are examined and estimated in terms of their implications for the future.

FUTURES THINKING involves DECISION-MAKING on both the individual and societal levels.



Knowledge Components of FUTURES THINKING

This area of the curriculum will address student questions about future desires and the ability of the present delivery systems to satisfy these desires.

1. FUTURE DESIRES

WHERE DO I WANT TO BE IN THE FUTURE?

Examine individual future desires in terms of basic and perceived needs to include consideration of:

- alternative lifestyles
- size of family unit
- career options
- concepts of success and happiness

WHAT DOES IT TAKES TO GET THERE?

Examine the means of satisfying these future desires in terms of:

- the kind of technology required

Consider:

Appropriate Technology means using a technology "more appropriate to the transition period we are in that that which now is conventionally used by our society in its continued pursuit of quantitative economic growth... to cure ourselves from our cheap energy addiction."[1]

Intermediate Technology means a return to a simpler decentralized technology. It does not mean abandoning sophisticated technology, but rather shaping it to our needs and humanizing it.

"Intermediate technology is here to help both those who choose alternatives to the present society, and those who are trying to adapt present society to more humane ways of living and working."[2]

[1] Yudelson, Jerry and Van Der Ryn, Sim, "What is Appropriate Technology?", Office of Appropriate Technology, Sacramento, Ca., June, 1976.

[2] Burchard, Preston, "What Do We Mean by Intermediate Technology?", Intermediate Technology, Report No. 1, Winter/Spring, 1976, p. 7.

- the resources available

Consider:	Immediate access to <u>natural, human and currency</u> resources required for the goal. Access to <u>primary means of production</u> for the fulfillment of the goal; most desires require a variety of technologies and producers.

- growth mangement strategies

Consider:	There will be limited access to certain resources; some will be in short supply.

2. PRESENT AND ALTERNATIVE DELIVERY SYSTEMS

HOW POSSIBLE IS THIS FUTURE IN TERMS OF PRESENT RESOURCE DELIVERY SYSTEMS?

Examine the consequences of continued development of present resource delivery systems and relate this to individual future desires:

- Determine present energy/resource consumption rates and patterns

WHAT ARE THE ALTERNATIVES TO THE PRESENT RESOURCE DELIVERY SYSTEMS?

Within the context of a particular worldview a new approach can be made to investigate and evaluate alternatives:

- The traditional approach asks "What can the future be?" in terms of merely extending available processes, making minimal changes. — PROCESS EVALUATION APPROACH

- A more optimistic, visionary approach asks "What should the future be?" and organizes whatever processes are necessary to achieve the stated goal. — STRUCTURE EVALUATION APPROACH

- A more holistic approach asks "How can we begin to define a desirable future?" and moves from a differentiated to a more integrated condition by focusing on long-term goals that are representative of a broad range of society. — STRUCTURPROCESS EVALUATION APPROACH

The $\boxed{\text{purpose}}$ of the knowledge components of FUTURES THINKING is:

1. To express future desires in terms of careers, lifestyles, and consumption patterns.

2. To examine in terms of resource expenditure the means of satisfying these desires.

3. To encourage voluntary decision-making that synchronizes resource consumption/lifestyle with available environmental resources.

4. To relate numbers 1 and 2 above to the aggregate level of social decision-making.

5. To introduce different approaches for evaluating future alternative resource delivery systems.

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RELATIONSHIP BETWEEN CONTENT MODEL AND REPRESENTATIVE NATURAL SCIENCE AND SOCIAL SCIENCE SUBJECT MATTER

The content model components just presented focus on environmental concepts, principles, and processes which are transdisciplinary. Table One identifies some example subject-matter areas or course topics which are associated with the intersections between each of the content components and traditional (Natural Science or Social Science) curriculum disciplines.

These subject-matter areas are offered only as general indicators since they would, of course, need to be further broken down and arranged by teachers or curriculum developers into topics suitable for students at specific grade levels.

TABLE ONE

Representative Subject Matter Topics for Infusion into Traditional Elementary and High School Courses Involving Environmental Education Holistic Concepts and Process Skills

	NATURAL SCIENCE CURRICULUM AREAS			SOCIAL SCIENCE CURRICULUM AREAS				
CONTENT MODEL COMPONENTS	CHEMISTRY PHYSICS	BIOLOGY ECOLOGY	GEOLOGY	SOCIOLOGY	PSYCHOLOGY	HISTORY ANTHROPOLOGY GEOGRAPHY	ECONOMICS	POLITICAL SCIENCE
ENVIRONMENT RELATED DECISIONS	Pollution analysis	Ecosystem simplification and environmental stability	Consumption patterns and resource depletion	Social roles and social mobility	Personally satisfying work roles	Environmental impact of past civilizations	Fiscal policy and environmental decisions	Government policy and environmental impact
PROBLEM-SOLVING AND DECISION-MAKING	Hypothesis formation and testing	Learning in living systems	Uniformitarianism	Social "deviance" and creativity	Values clarification	Art and the evolution of technique (Mumford)	Cost-benefit analysis	Pluralism and the art of muddling through
ANALYTICAL TOOLS FOR UNDERSTANDING ENVIRONMENTAL SYSTEMS	Fundamental concepts of energy	Order and energy flow	Global ecological systems (water cycles plate techtonics, etc.)	Organization of social systems	Self-transcendence	Evolution of hierarchical social systems	Throughput (G.N.P.) and a growth economy	Cybernetics in city hall (information feedback in government)
RESOURCE DELIVERY SYSTEMS	Energy efficiencies	Living resources and sustainable yield	Formation/location of fossil fuels and mineral resources	Social displacement by large-scale delivery systems	Dehumanization in large technological systems	Evolution of energy use	Centralization and quantity pricing	Public subsidy of large-scale centralized systems
HOLISTIC LIFESTYLE ASSESSMENT	What is biodegradable?	"Ecological lifestyles"	Impact of land use policy	Socialization and the common good	Re-definition of human needs (Maslow's need hierarchy)	Comparative evolution of social systems	"Voluntary simplicity"	Implementation of national energy policy
FORECASTING PLANNING AND POLICY FORMATION	The atom and technological determinism	Advanced medical technology	Earthquake prediction	Collective "good" uses private interest	Human need and utopian design	Environmental planning in historical perspective	"Future discounting" and self-fulfilling prophecy	Crisis management uses long-range planning
FUTURES THINKING	Technological limits and alternate technology	Future evolution of living systems	Global (re-) distribution of resources	Reintegration of community and restructuring of social roles	Search for self	Past world views and future scenarios	Transition to steady state economy	Democratic vs. authoritarian politics-cooperative pathfinding