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ABSTRACT

The model is presented in five sections: (1) orientation; (2) content specifications; (3) curriculum management specifications; (4) implementation model; and (5) content sourcebook. These sections are intended to characterize and integrate the systems complex of energy/environmental education and teacher training. They are intended as orienting documents for curriculum or program developers. Desired outcomes from the model are: (1) development of high school teachers' understanding of energy/environmental education; and (2) development of their professional capabilities in devising instructional/learning arrangements which communicate a similar understanding to students. (Author/RE)

THE HIGH SCHOOL ENERGY/ ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL

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THE HIGH SCHOOL ENERGY/ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL

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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.

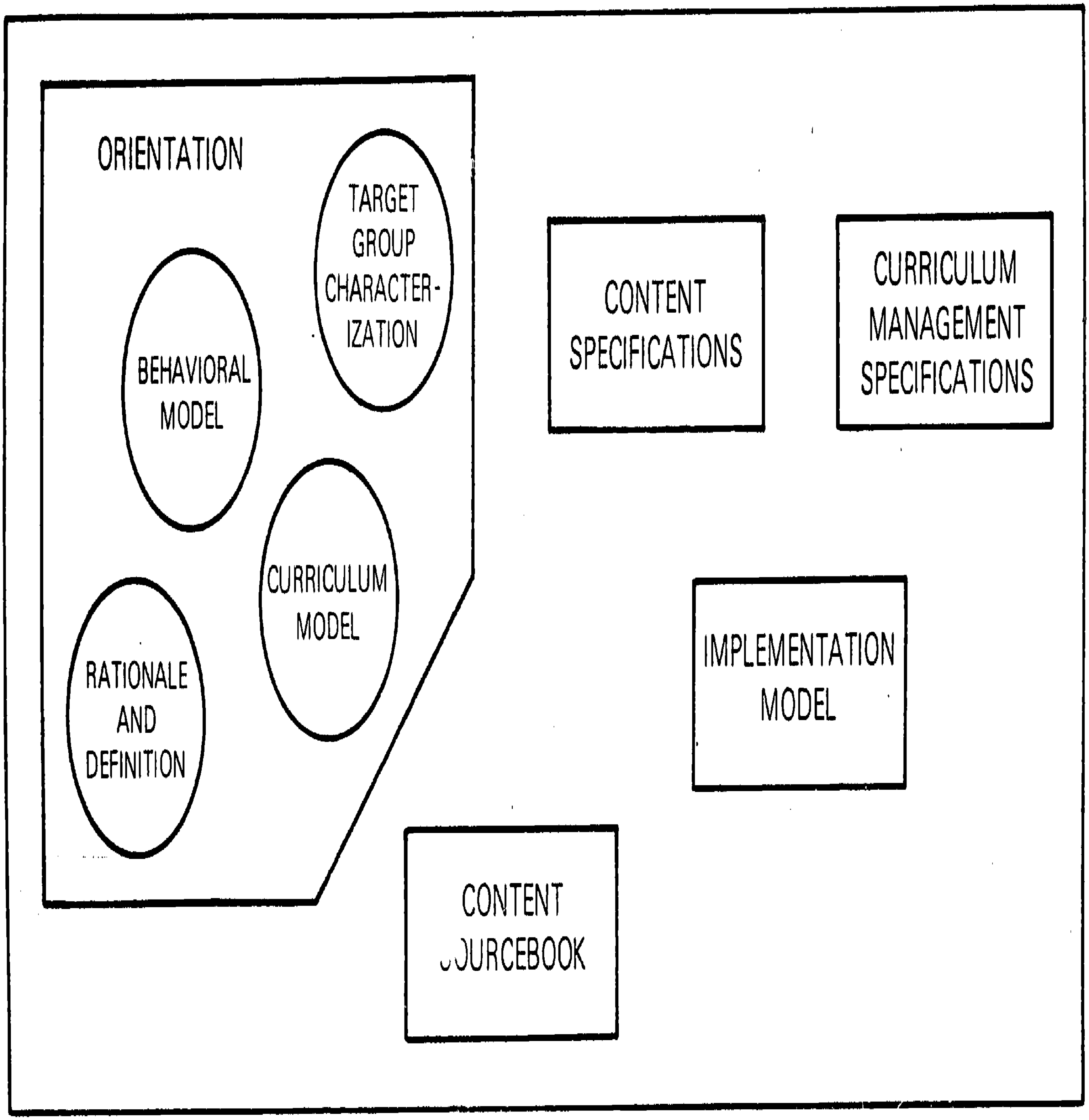
PREFACE

The High School Energy/Environmental Education Teacher Training Model is presented in the following documents:

- Orientation
- Content Specifications
- Curriculum Management Specifications
- Implementation Model
- Content Sourcebook*

These documents represent an attempt to characterize and integrate the systems complex of energy/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 energy-focused environmental education programs and training products which: (1) develop high school teachers' understanding of EE, and (2) develop their professional capabilities in devising instructional/learning arrangements which communicate a similar understanding to their students.

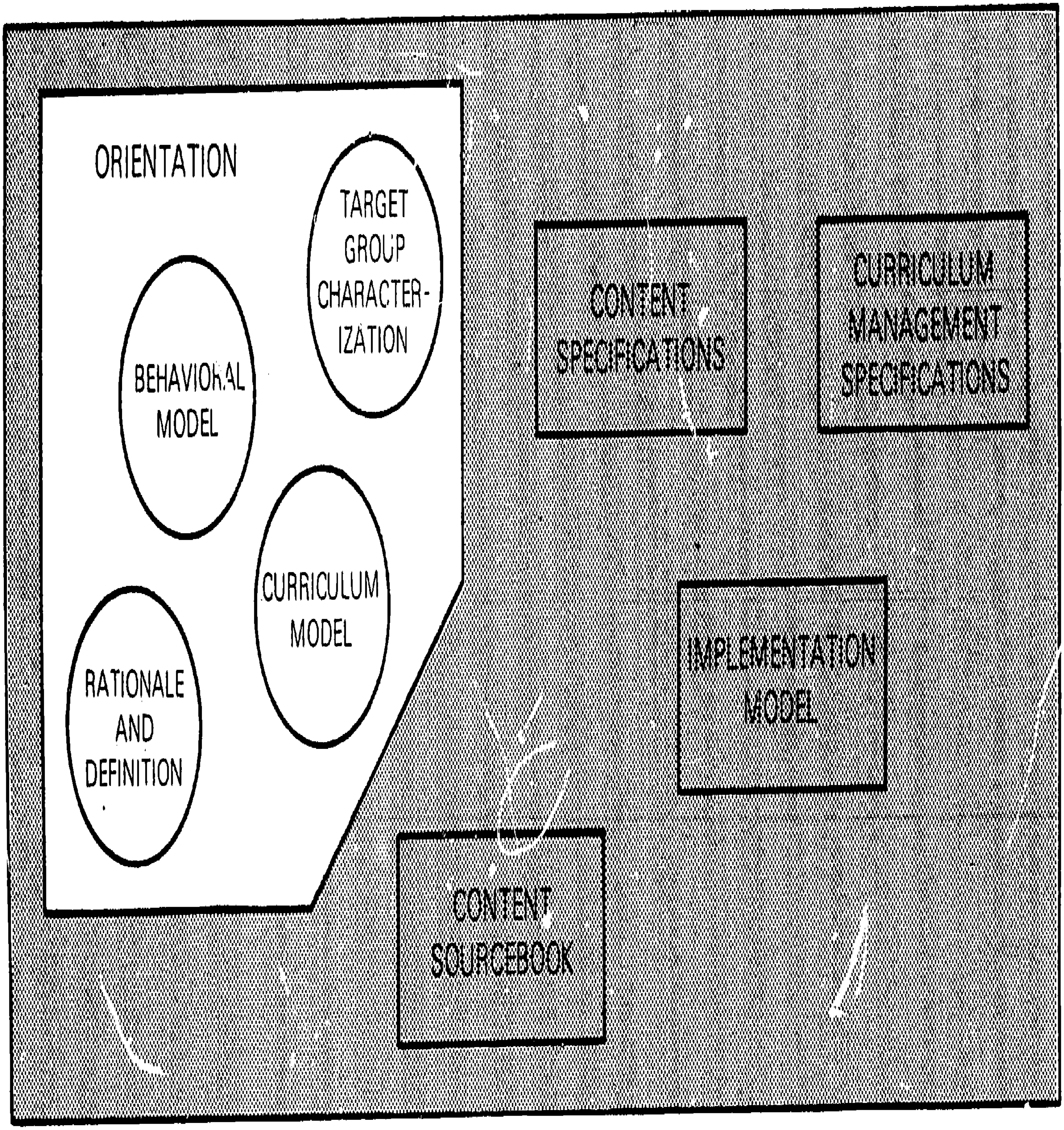
*The Environmental Education Content Sourcebook will be available as a separate publication.



ENERGY/ENVIRONMENTAL EDUCATION
TEACHER TRAINING MODEL

Orientation

THE HIGH SCHOOL ENERGY/ ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL



ENERGY/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 idea of environmental education is well known, widely supported and the subject of much discussion internationally, nationally, regionally and locally, its implications and characteristics 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 <u>educational</u> 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 <u>responsibly</u> 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 <u>components</u> and the <u>interactions</u> 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] <u>Federal Register</u>, 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, <u>Environment-based Environmental Education: Inventory, Analysis, and Recommendations</u>, 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 human system (social, economic, technological)
- Interactions within the total natural system (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.

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

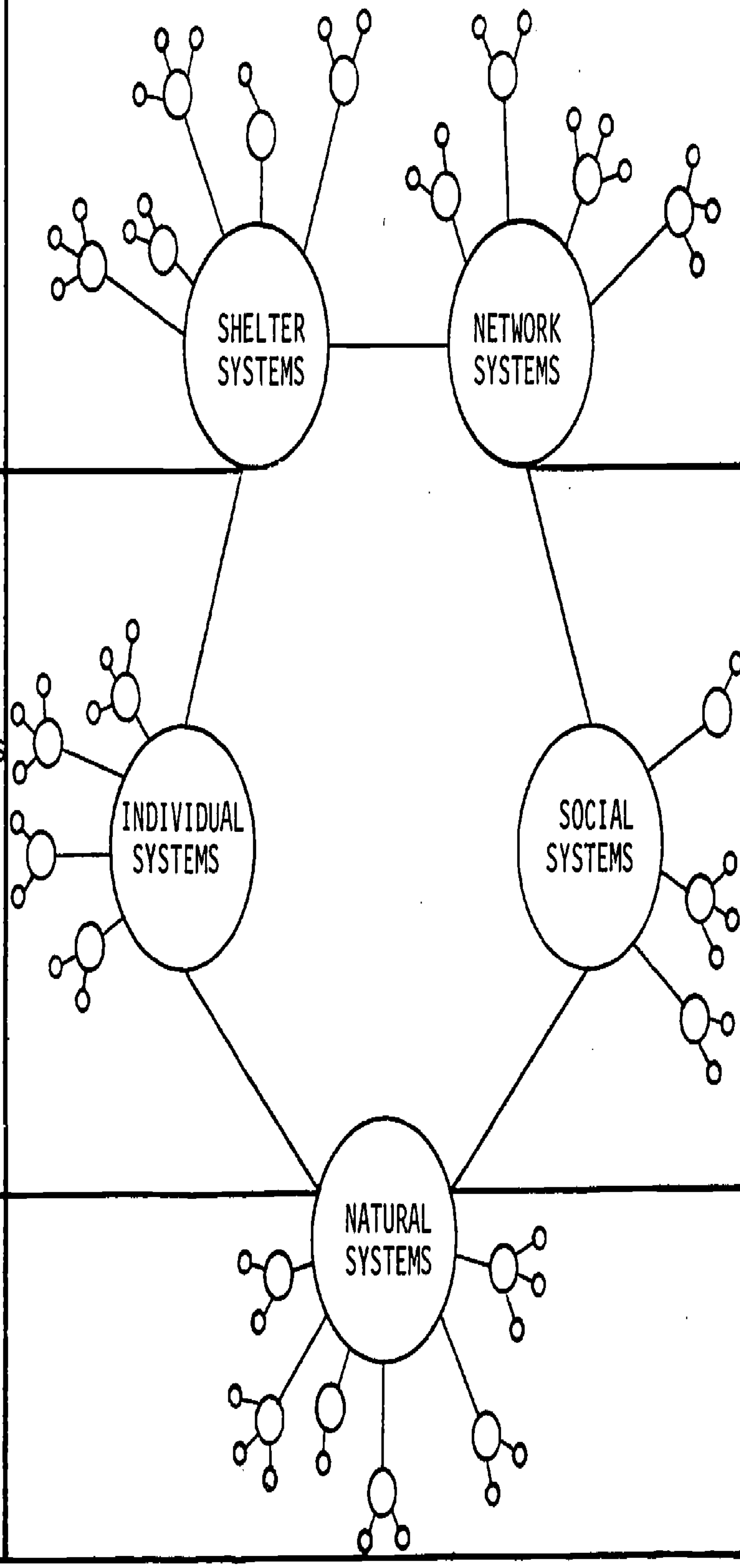
	KEY ENVIRONMENTAL ENTITIES	EKISTIC VIEW	EKISTIC SYSTEM MODEL
TECHNO SYSTEMS	Pollution Resource Allocation Technology Transportation Urban and Rural Planning	SHELTERS Housing Community facilities NETWORKS Public utility systems Transportation systems Communication systems	
HUMAN SYSTEMS	Population (dynamics) 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:

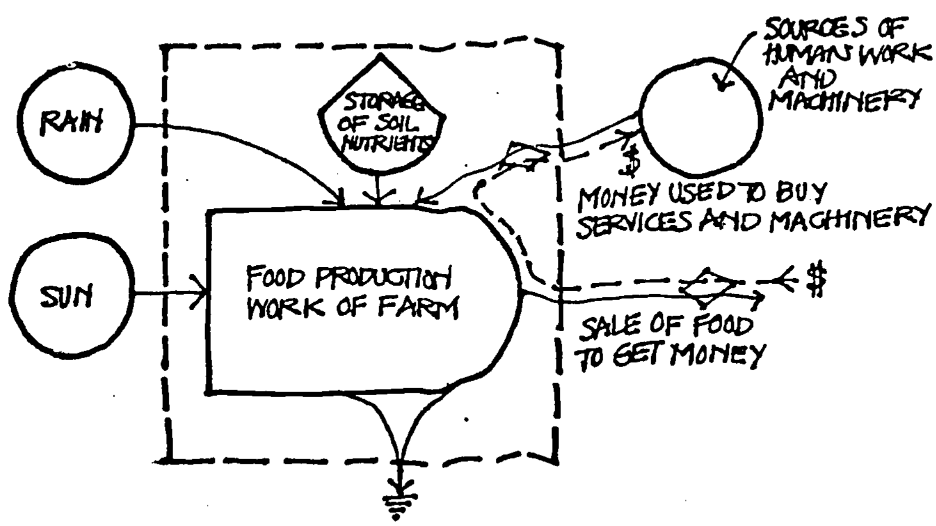


Fig. 2. A Farm System

[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.

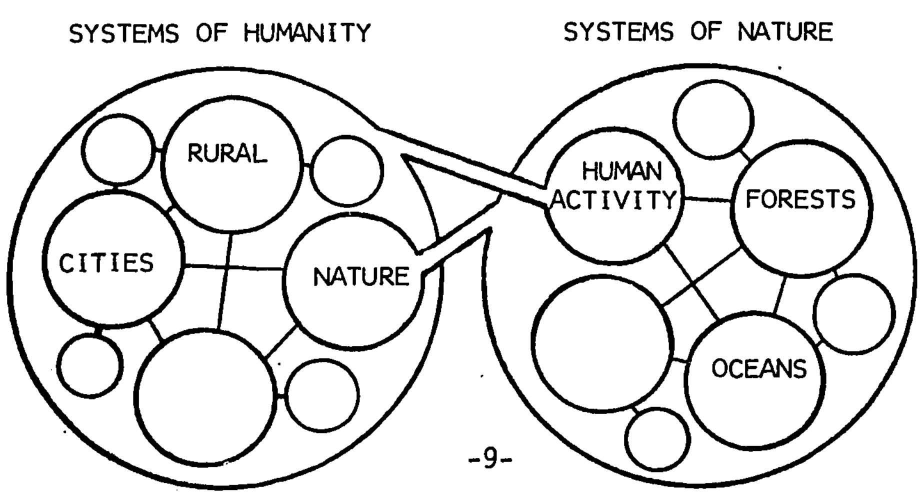
Almost ten years after the Earth Day activities of the late sixties, three "truths" have emerged after considerable cultural introspection by the most powerful and power-consuming nation on earth:

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

[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.

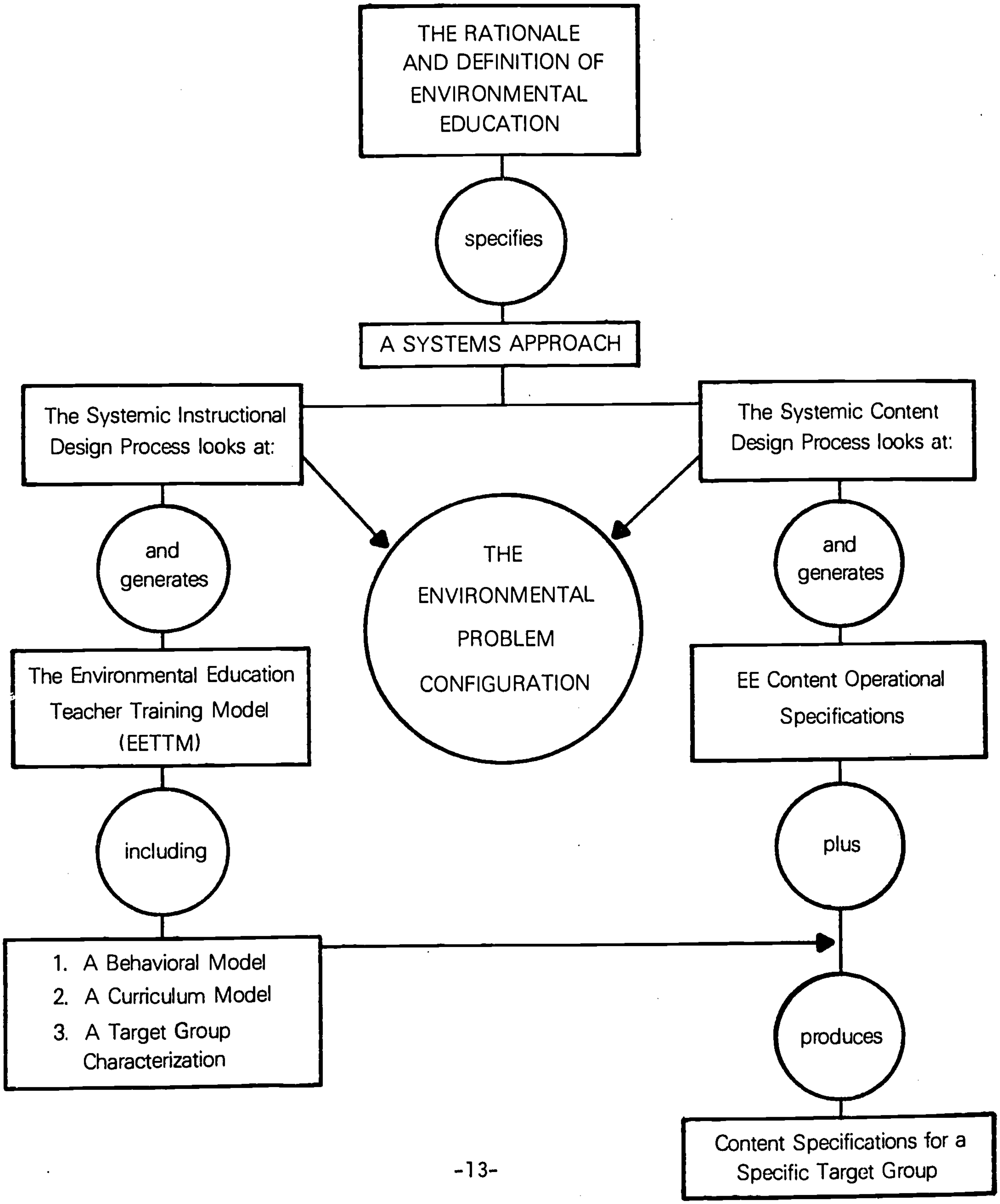
Further, because of the comprehensive and holistic nature of the subject matter, it is not readily subsumed into any one specialized discipline, and therefore, the EE model must be integrative--a useful framework for showing the environmental relationships disciplines have with one another.

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?

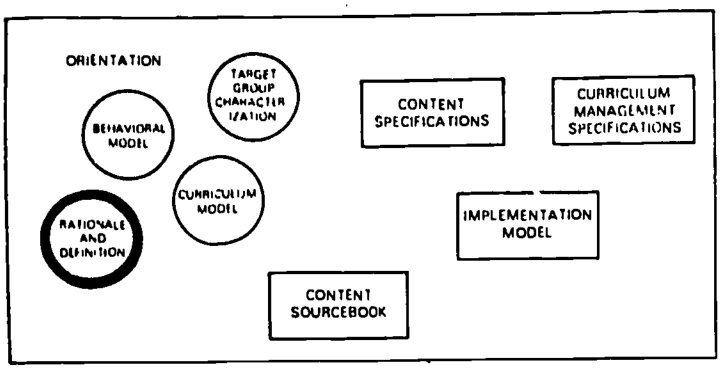
B. THE COMPONENTS OF THE ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL

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.

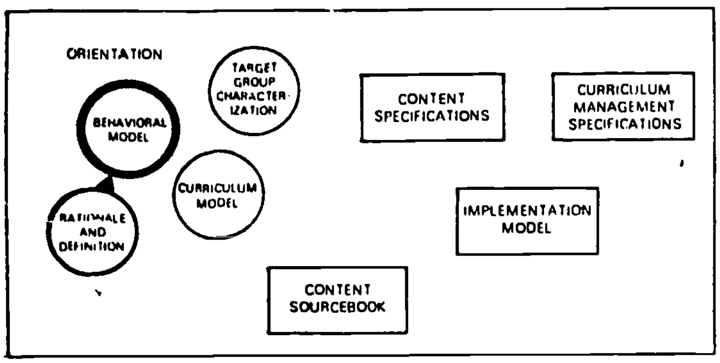
Practitioner Questions	Relevant EETTM Components
• What do I need to know?	CONTENT SPECIFICATIONS
• What materials/resources do I need?	CONTENT SOURCEBOOK
• What instructional/learning arrangements are needed?	CURRICULUM MANAGEMENT SPECIFICATIONS
• What physical and logistical arrangements are needed?	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.

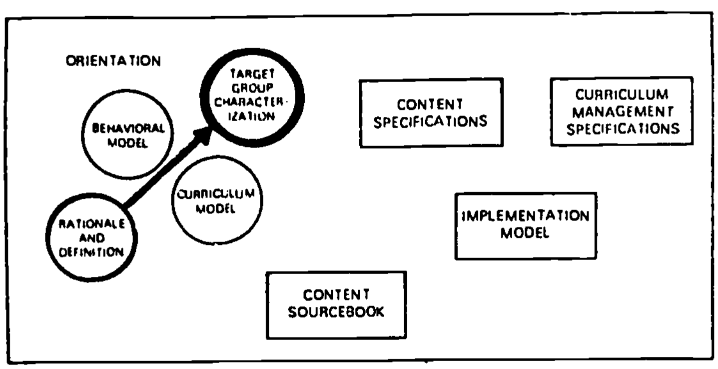
ENERGY/ENVIRONMENTAL EDUCATION
TEACHER TRAINING MODEL



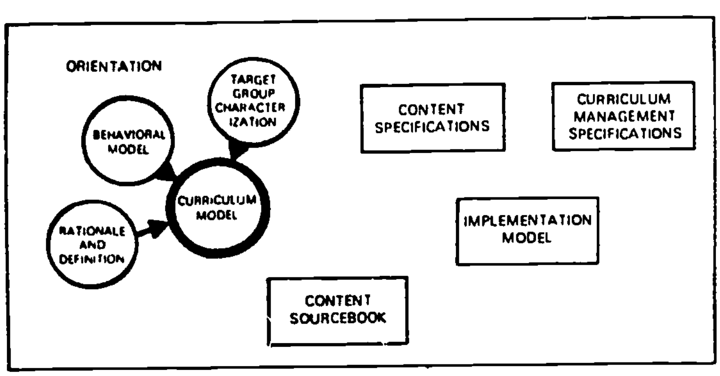
1. The <u>Rationale for and Definition of Environmental Education</u> presents an exposition of the Environmental Education Act as well as a definition of environmental education.



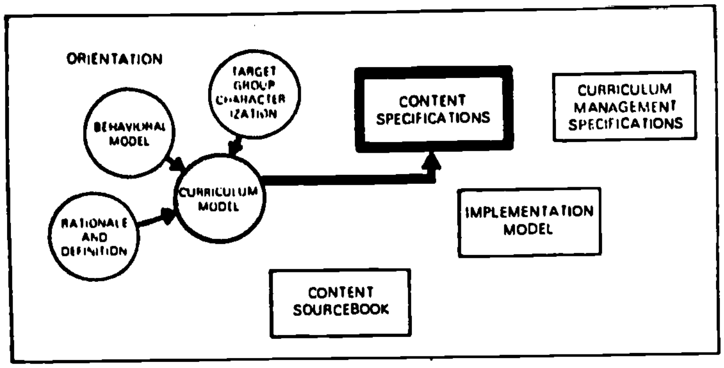
2. The <u>Behavioral Model</u> characterizes the general knowledge, skill and attitude requirements which define the literate, competent, and aware energy/environmental education teacher. It is derived from the Rationale.



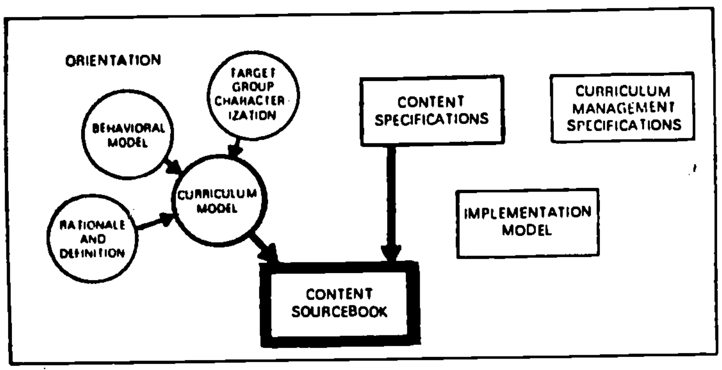
3. The <u>Target Group Characterization</u> defines the target group as high school science and social science teachers and provides a means to assess their current level of competence in order to ensure the model's compatibility with their needs.



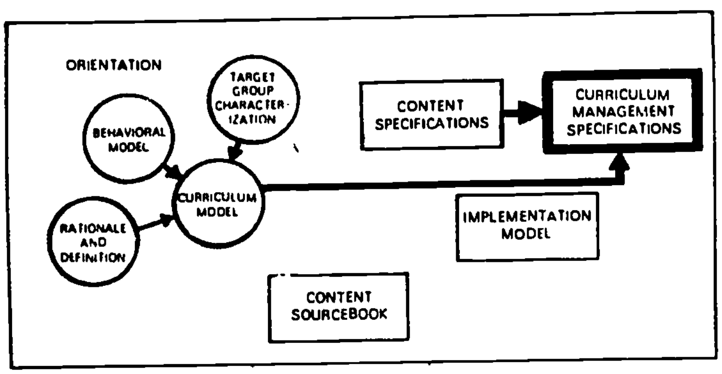
4. The <u>Curriculum Model</u> provides an organized description of the various curriculum content domains within which potential teachers need to attain competence. It is consistent with the Rationale and represents an elaboration of the Behavioral Model and the Target Group Characterization.



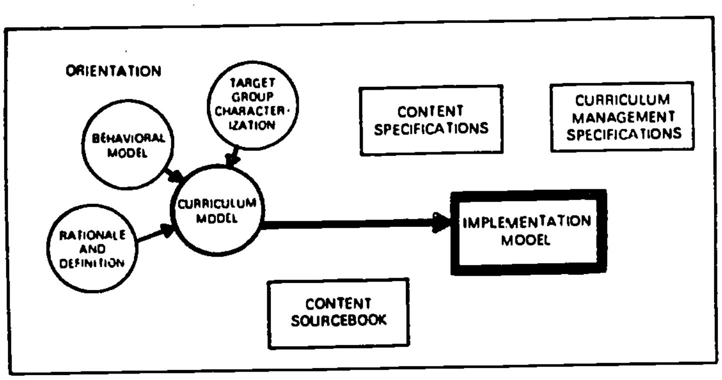
5. The <u>Content Specifications</u> present the knowledge components for energy/environmental education and a description of their instructional foci and purposes. These specifications were designed to satisfy the requirements of the knowledge component of the Curriculum Model.



6. The <u>Content Sourcebook</u> 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 <u>Curriculum Management Specifications</u> present general instructional arrangements by which teachers can purpose, plan, implement and evaluate a high school energy/environmental education course. This component was derived from and further elaborates the skills component of the Curriculum Model and the Content Specifications.



8. The <u>Implementation Model</u> 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.

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[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 diminishes 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 <u>goal achievement</u> rather than <u>proper process practices</u>.

[6]For a discussion of nurturing and exploiting the land, see Wendell Berry, <u>The Unsettling of America</u>, 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.

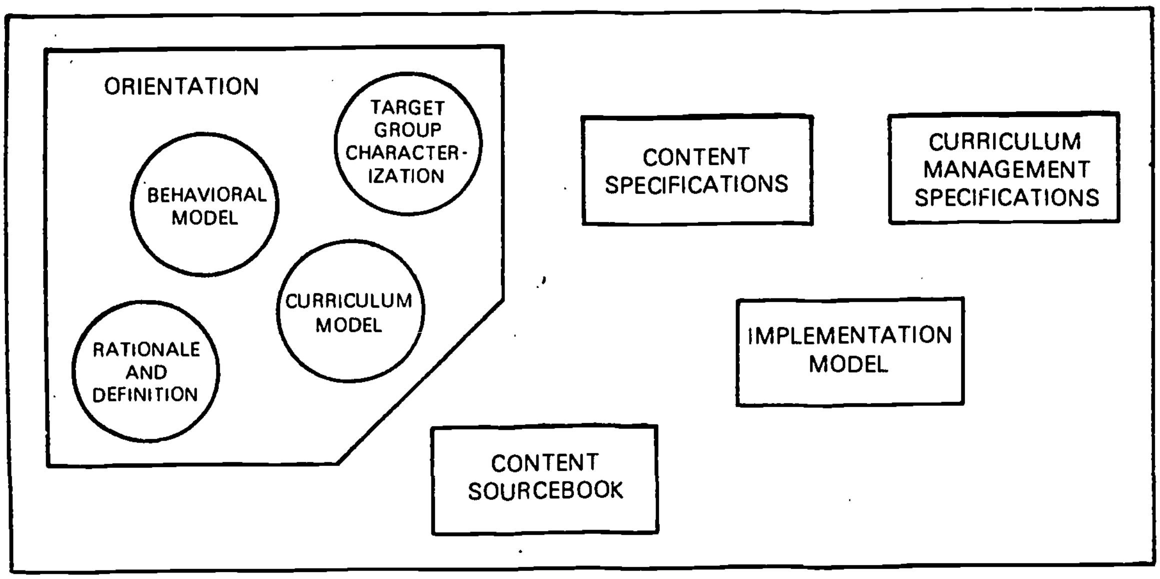
What will emerge however, as the result of viewing a larger field, are new patterns previously imperceptible either because the field was too small or there were too many details to see the overall pattern.

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.



ENERGY/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 energy/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 energy/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 energy/environmental context.

These components are as follows:

- Energy-related Decisions
- Problem-solving and Decision-making
- Analytical Tools for Understanding Energy Systems
- Fundamental Concepts of Energy
- Holistic Lifestyle Assessment
- Energy Delivery Systems
- Forecasting, Planning, and Policy Formation
- Futures Thinking

These content components emphasize three major aspects of any energy/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 Energy/Environmental Education Teacher Training Model (i.e., Curriculum Management, Content Sourcebook), these content components constitute the major element in designing and developing holistic, energy/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 energy/environmental education subject matter and basic processes of the culture. It is intended to help energy/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 a high school energy/environmental education curriculum. These specifications describe arrangements by which teachers can:

- select, develop and implement an energy-focused 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 energy/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 <u>and</u> institutional arrangements needed to plan, implement and evaluate a comprehensive and effective energy/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			Orientation			Content Specifications	Curriculum Management	Implementation
	Subject Matter/ Process Matrix	Content Descriptions	Annotated Bibliography	Rationale[1]	Behavior Model	Curriculum Model			
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	*	*	*		*	*	*	*	*

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PART FIVE
BEHAVIORAL MODEL

The purpose of the Behavioral Model for Energy/Environmental Education Teacher Training is to characterize the general knowledge, skill, and attitude requirements which define the literate, competent, and aware energy/environment 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 energy/environmentally literate teacher as one who understands the basic concepts and principles of energy, and the processes and factors to be utilized or considered for effective identification and evaluation of alternative solutions to energy/environmental problems.

These general requirements include an understanding of:

1. The energy significant relationships within and between environmental entities, phenomena, systems, and sub-systems.

2. The systems structure, energy requirements (needs), and impacts (degree of need satisfaction, problems, conflicts) of these relationships.

3. The reciprocal effects of human activities and their implication for production and consumption, energy/environmental policies and decision-making.

4. The holistic contexts (natural and man-made) within which energy, energy problems, and alternative energy problem solutions must be viewed for comprehensive, responsible, and future-oriented decision-making.

5. Strategies of inquiry and decision-making appropriate to analyzing and evaluating energy issues or problems and energy solutions.

B. GENERAL SKILL REQUIREMENTS

The management requirements of the Behavioral Model characterize the energy/environmentally competent teacher as one who is able to purpose, plan, implement, and evaluate instructional/learning arrangements which transmit to students an understanding of the subject matter, concepts, and principles of energy. These instructional/learning arrangements will help the students develop the capability of comprehending energy problems and issues from a holistic, transdisciplinary perspective.

These general skill requirements include the abilities to:

1. Purpose an energy/environmental curriculum by setting energy awareness learning objectives which are consistent with students' abilities and needs.

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

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

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

C. GENERAL ATTITUDE REQUIREMENTS

The general practices or attitude requirements of the Behavioral Model characterize the <u>energy/environmentally aware teacher</u> as one who demonstrates through words and actions:

- an appreciation of the holistic, transdisciplinary nature of energy, energy systems, and energy problems 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 energy/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 energy/environmental problems and issues with students.

2. A tendency to seek out and emphasize humanity-environment interrelationships which lead to "productive harmony" regarding energy production and use.

3. A tendency to search for and discuss energy policies which reflect long-range, as well as short-range, concern for the impact of energy programs and activities on environmental quality.

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

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

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

PART SIX

TARGET GROUP CHARACTERIZATION

The purpose of the Characterization of the Target Group is to provide the curriculum designer/developer with a description of the teachers who will be trained. It is not feasible to design a training model for all secondary school teachers. A close look at the energy/environmental Content Specifications indicates that the topics addressed are primarily in the sciences (particularly in physics) and in the social sciences. Given the interdisciplinary nature of the EE content and the fact that science and social science teachers are already familiar with related subject matter, we have defined the target group as high school science and social science teachers.

This characterization will offer the curriculum designer/developer a means to assess these teachers' current level of competence with respect to the knowledge, skill and attitude specifications outlined in the Behavioral and Curriculum Models. This will be done in terms of (1) the teacher's professional training and (2) the instructional materials being utilized by the teacher in the classroom.

A. PROFESSIONAL TRAINING

1. Profile of secondary education science majors[1]

   a. Possible areas of concentration

      General Science
      Physics
      Biology (Botany, Zoology)
      Chemistry
      Geology
      Earth Science

   b. Professional education requirements

      The common sequence is 2 or 3 methods courses followed by one semester of student teaching or internship. The methods courses focus on topics such as psychological foundations of learning, lesson and unit planning, and teaching strategies.

The professional preparation received by secondary science teachers is very discipline bound. In most Bachelor of Science programs, students have both a major and minor in one of the areas of concentration listed above. Unless the program is so designed, there are few opportunities available for inter- or transdisciplinary studies. The general science major is the one with the broadest overview of the concerns and contributions of the separate disciplines. During the professional training sequence, prospective teachers are introduced to various planning and teaching strategies, but few opportunities are provided to practice these skills in either real or simulated classroom settings. Science teachers' exposure to innovative materials and methodologies has come primarily through large science projects implemented mostly during the '60's--i.e., Physical Science Study Committee, Earth Science Curriculum Project, Biological Science Curriculum Study, etc.

[1]These depictions of the professional training sequence were derived by examining a variety of teacher training programs as outlined in college catalogs such as University of California-Berkeley; University of Wisconsin-Madison; University of Oregon-Eugene, Ohio State University-Columbus, University of Washington-Seattle.

2. Profile of secondary education <u>social science</u> majors

a. Possible Areas of Concentration

Sociology
Economics
History
Political Science
Social Science
Psychology

b. Professional education requirements

The common sequence of methods courses and student teaching experience seems to be very similar to that for the science degree program. The prospective social science teacher usually takes the following types of methods courses:

(1) Social Studies in Secondary Schools focused on the nature of inquiry, student needs, learning theory, lesson planning

(2) Curricula Materials, Resources and Teaching Strategies for Secondary Social Studies.

These courses are followed by a student teaching/intern experience.

Again, the professional training pattern relies on the dominance of particular disciplines. The exception to this is found in programs designed for teachers who will be teaching general "social studies" classes as opposed to teaching classes in a particular social science (i.e., economics, history, psychology, etc.).

B. INSTRUCTIONAL MATERIALS

There is a wide variety of instructional materials available for classroom use in secondary science and social science courses. Which of these materials are actually being used by teachers and how relevant are they to the interdisciplinary, systemic approach of the EETTM?

A study conducted by the Education Development Center (EDC) is helpful in addressing these questions.[2] The EDC study reviewed 143 curricula materials, both student and teachers' guides, in a variety of subject matter areas to include: biology, botany, chemistry, civics, ecology, English, environmental studies, future studies, general/natural science, geography, geology, global studies, government, history, social studies, technology, world problems/world development.

EDC findings with respect to four specific areas are of particular interest in terms of the aim and focus of the EETTM:

- Interdisciplinary Focus
- Systems Concepts/Analysis
- Problem-Solving Skills
- Energy Specific Materials

1. Interdisciplinary Focus

Of the curricula reviewed, only 16% had a multidisciplinary focus and of this group, many were cross disciplinary (using one perspective on one issue) rather than interdisciplinary (using several disciplines to look at the same issue). The discipline-bound nature of the sciences and social sciences at the high school level has not encouraged the development of interdisciplinary materials. And in fact, publishers do not usually commission interdisciplinary materials because they tend to sell less well than traditional, narrowly focused texts.

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[2] <u>Growth Implications and the Earth's Future: A Study of Curriculum Materials and Student Views</u>, Education Development Center, Inc., Newton, Massachusetts, 1976.

2. Systems Concepts/Analysis

Systems concepts and behavior were presented in 18% of the materials surveyed by EDC. In many instances, however, EDC found that the courses which attempted to teach about systems focused only on conveying systems concepts, giving too little consideration to the subject matter area. Only 4% of the materials focused on systems analysis skills and these tended toward describing how a system works rather than enabling students to create and evaluate their own models.

3. Problem-Solving Skills

The majority of materials surveyed by EDC utilized a very narrow conception of problem-solving. Only about one-third of the curricula reviewed asked students to assess the extent of predefined problems. And EDC noted that even among the 18% that provide opportunities for students to practice problem-solving skills development, most focus on data gathering rather than designing alternatives or choosing among solutions.

4. Energy Specific Materials

One of the questions asked by EDC was: How Comprehensively Do Existing Curricula Teach About Food, Population, and Energy? Their report on the energy materials, in part, is as follows:

> "Materials on energy, such as the Federal Energy Administration's primary school booklet, *Energy Activities with Energy Ant*, tend to focus on the need for energy and possible ways to conserve it. Students are encouraged to cut down on their own and their families' direct energy consumption. But energy use in industry (and thus our indirect use of energy through consumption of manufactured goods) is not explored. The pros and cons of utilizing various energy sources (nuclear power, coal, oil) are discussed, but sources such as solar energy, wind power, and geothermal energy are not included as alternatives. There is no discussion of renewable vs. nonrenewable energy sources. And the various energy "qualities" involved (electricity, for example, is more versatile than sunlight, water, or nuclear power) are not presented. Many materials provide a slim data base, then ask students to weigh the costs and benefits of complex energy alternatives."[3]

[3]Ibid, p. 84.

Based on information regarding the teachers' professional training and the instructional materials that are available, the following guidelines for developing training materials should be considered:

- Since most science and social science teachers are unfamiliar in dealing with interdisciplinary materials and holistic concepts, they will be required to learn new ways of thinking about and integrating materials.

- Given the great number of materials available, the teachers need guidelines and criteria for examining potential resource materials in terms of the EE Content Specifications. Can they be used in a holistic, systemic EE curriculum?[4]

- An inservice team learning workshop is a familiar learning arrangement for teachers. A team learning mode such as this provides application opportunity for the teachers as well as facilitating the interdisciplinary cooperation needed to present an energy education course.

[4] A model approach for deriving criteria and using them to assess materials is included in the EDC survey described earlier.

TARGET GROUP CHARACTERIZATION

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PART SEVEN
CURRICULUM MODEL

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

- acquire a holistic, systemic awareness and understanding of energy
- provide instructional arrangements which transmit this awareness and understanding to students, and develop in them a worldview and decision-making capability consistent with energy/environmental awareness

To accomplish these ends, three teacher competence domains have been identified which are as follows:

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

A. MASTERY OF HOLISTIC ENERGY/ENVIRONMENTAL CONTENT

There are eight knowledge areas in which teachers need to acquire competence in order to develop a holistic understanding of energy/environmental curriculum content. These knowledge areas, which emphasize individual and societal levels of decision-making related to energy production and use, problems, and issues, would, if sufficiently elaborated, provide a basis for teachers to select and develop an energy/environmental curriculum appropriate to their students. The knowledge areas described here are presented in more detail in the Energy/Environmental Content Specifications.

1. The first knowledge area deals with the conceptual and operational bases for understanding energy as it relates to the individual decision-maker. The specific knowledge components are:

   a. Energy-related decisions made by the individual which orient the student to decision-making responsibilities affecting career choices and energy consumption.

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

   c. Analytical tools for understanding energy systems which include general systems themes and systems diagramming. These can be used to describe the energy relevant properties and interactions of systems which operate within the biosphere.

2. The second area deals with the conceptual and operational bases for understanding energy as it related to societal decisions which provide the means for satisfying aggregate lifestyles. This area is composed of the following knowledge components:

   a. Holistic lifestyle assessment which describes basic human needs and derived human needs in real energy terms.

   b. Energy delivery systems which supply renewable (e.g., solar, hydroelectric, geothermal) and non-renewable (e.g., petroleum, natural gas, coal) resources to satisfy the basic and derived human needs of society. This would include the concepts of net energy and energy quality as bases for selecting or evaluating energy resources and delivery systems.

   c. 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.

   d. Futures thinking which examines combinations of careers, lifestyles, energy production and consumption, and their implications for the future.

The degree of competence which a teacher eventually achieves within any given energy/environmental content component, is expected to vary according to the teacher's:

- subject matter specialty (e.g., Social Science, Natural Science, etc.)
- degree of prior experience with energy/environmental topics
- personal preferences or interests
- particular focus or point of view chosen for arranging and presenting an energy 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' energy awareness through an appropriate energy/environmental curriculum content. (The skill areas described here will be more fully elaborated in the Energy/Environmental Curriculum Management Specifications.)

1. The first area deals with purposing an energy education curriculum. This involves establishing the parameters within which learning is to occur by:

   a. Setting student learning objectives which are derived from the energy/environmental curriculum content.

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

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

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

   b. Developing useful contexts (e.g., solar power generation in the San Joaquin Valley) which embody chosen energy/environmental principles, concepts, and factual data.

   c. Selecting appropriate instructional/learning arrangements for teaching the energy/environmental content. In making such arrangements, the 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 energy/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 energy 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 energy curriculum content, e.g., case studies, field trips, demonstrations, simulations, etc.

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

4. The fourth skill area deals with evaluating the planned energy 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 energy teaching/learning context including the energy 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 energy 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 teacher (or curriculum developer) has in carrying out the activities indicated for purposing, planning, implementing, and evaluating.

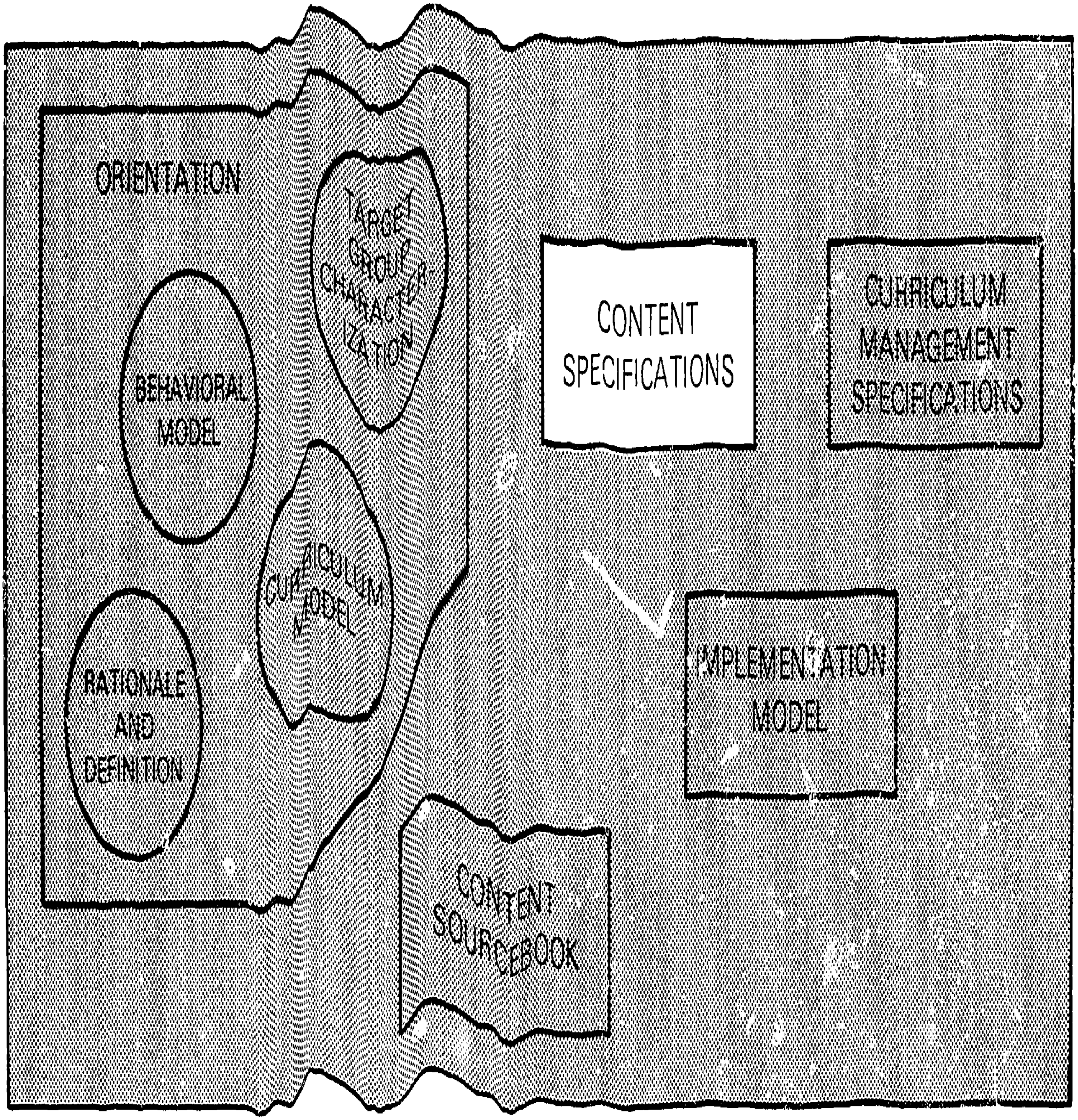
C. PERSONAL COMMITMENT TO DEVELOPING ENERGY/ENVIRONMENTAL AWARENESS IN STUDENTS

Commitment to developing energy/environmental awareness in students should begin to emerge as teachers gradually acquire an understanding of the holistic energy/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 teachers immerse themselves in the holistic energy/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 HIGH SCHOOL ENERGY/ ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL



ENERGY/ENVIRONMENTAL EDUCATION
TEACHER TRAINING MODEL

TABLE OF CONTENTS

INTRODUCTION

The Content Specifications component of the high school energy education model outlined on the following pages is oriented toward providing the learner with a systemic conceptual and operational basis for understanding energy 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 viewpoints. The use and conservation of energy is approached from both the production and consumption points of view as they relate 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 energy education as related to 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.

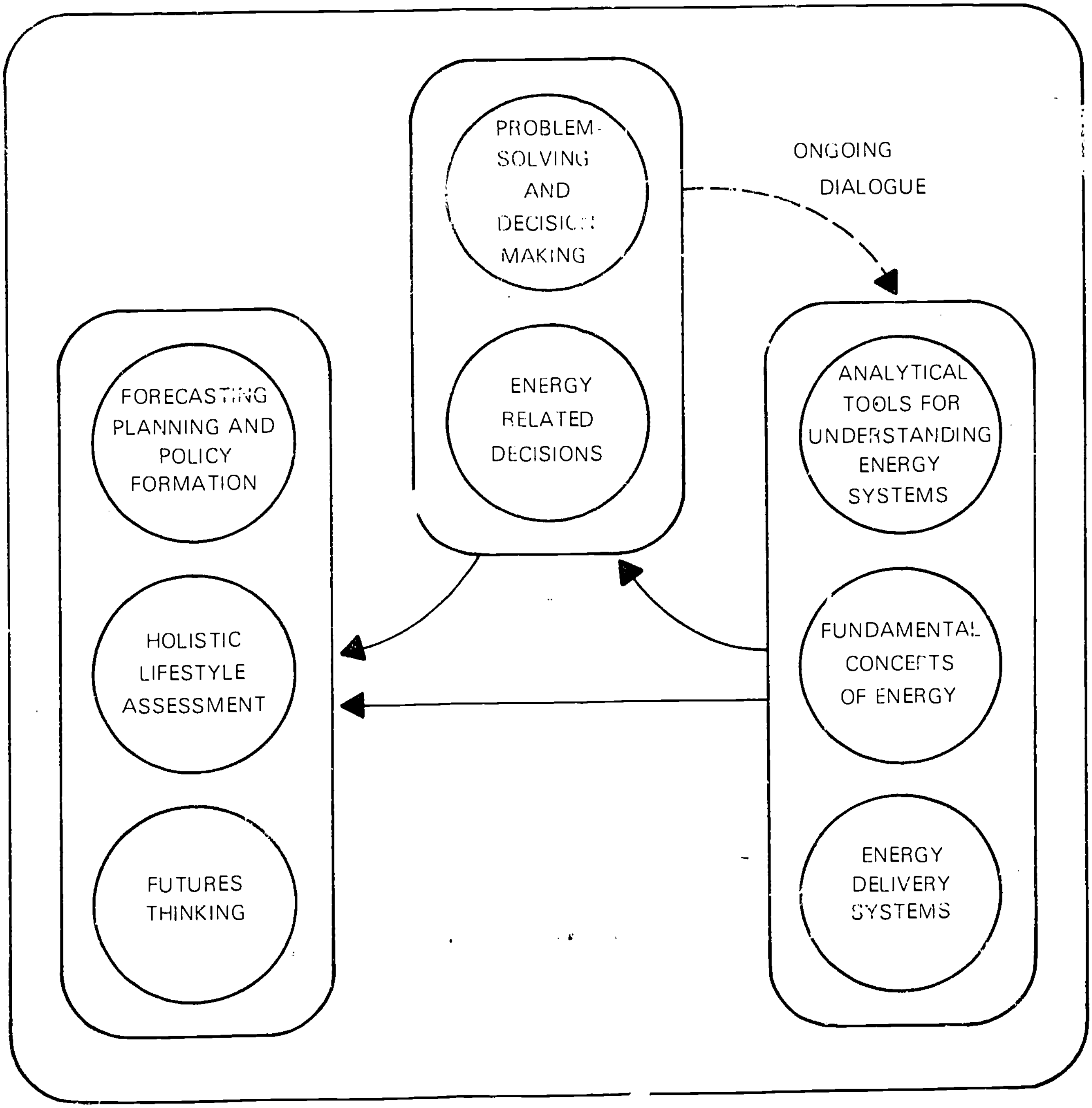


FIGURE 1.

CONTENT MODEL FOR HIGH SCHOOL ENERGY/ENVIRONMENTAL EDUCATION

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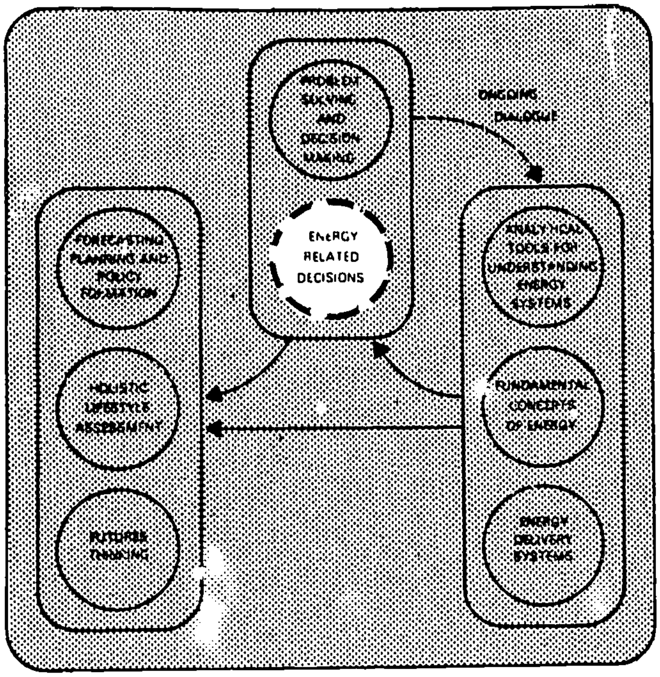
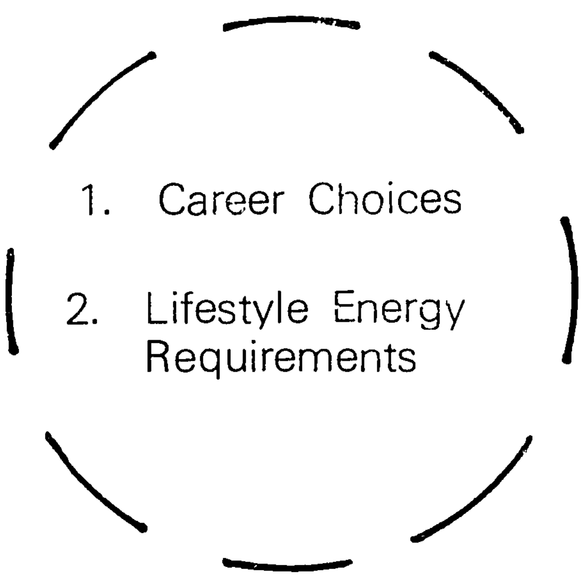
THE COMPONENTS OF THE HIGH SCHOOL ENERGY CONTENT MODEL

ENERGY-RELATED DECISIONS



CONTENT MODEL FOR HIGH SCHOOL
ENERGY/ENVIRONMENTAL EDUCATION

ENERGY-RELATED DECISIONS focuses on the high school student as a person with decision-making responsibilities in two major areas: career choices and product consumption.



Knowledge Components of
ENERGY-RELATED DECISIONS

This area of the high school energy curriculum will explore decisions affecting an individual's career choice as well as the energy consumption pattern of the chosen life-style.

1. CAREER CHOICES

Classify a variety of job opportunities according to their energy implications.[1]

- Are they directly or indirectly related to energy products?
- Are they directly or indirectly related to fiscal procedures that account for the many aspects of generating energy products?[2]

2. LIFESTYLE ENERGY REQUIREMENTS

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

- What is the energy "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 energy is needed.

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

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

[4] See ENERGY DELIVERY SYSTEMS for a discussion of energy "cost accounting."

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

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

2. To establish a framework for describing how energy is related to each of our lives (see HOLISTIC LIFESTYLE ASSESSMENT and ENERGY DELIVERY SYSTEMS).

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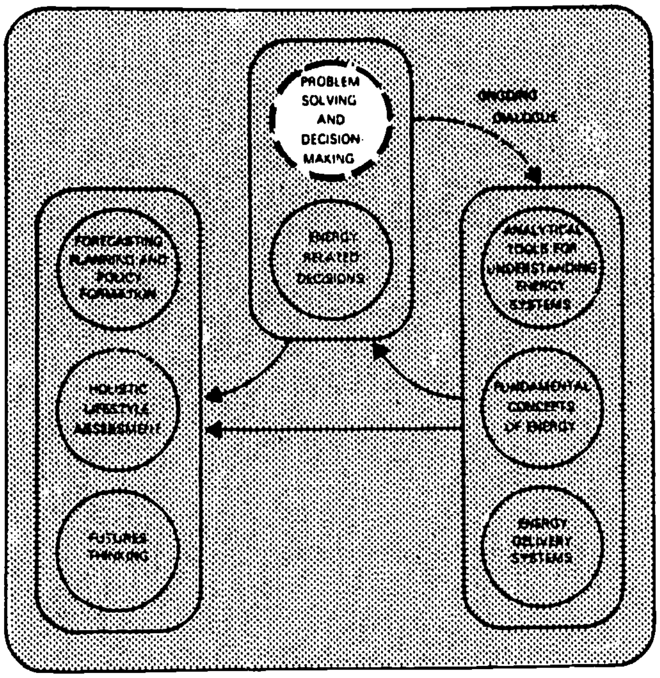
PROBLEM-SOLVING AND DECISION-MAKING



CONTENT MODEL FOR HIGH SCHOOL ENERGY/ENVIRONMENTAL EDUCATION

Energy/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.

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

Knowledge Components of PROBLEM-SOLVING AND DECISION-MAKING

This area of the high school energy 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

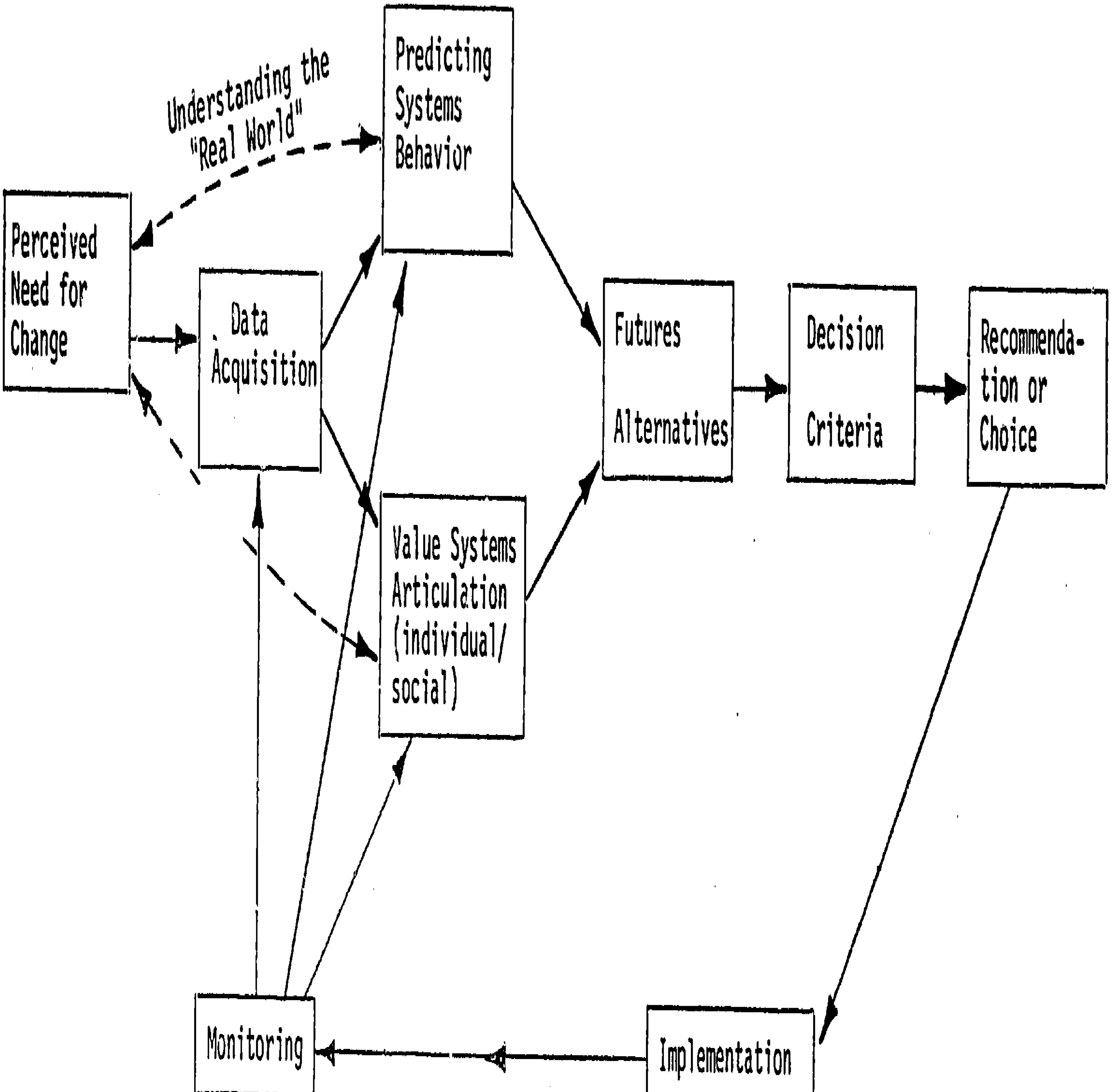
(5) Generation of futures-oriented alternatives

(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



A GENERIC COMPLEX DECISION-MAKING MODEL

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The purpose of the knowledge components of PROBLEM-SOLVING and DECISION-MAKING is:

1. To introduce some problem-solving routines.

2. To introduce a generic complex decision-making strategy.

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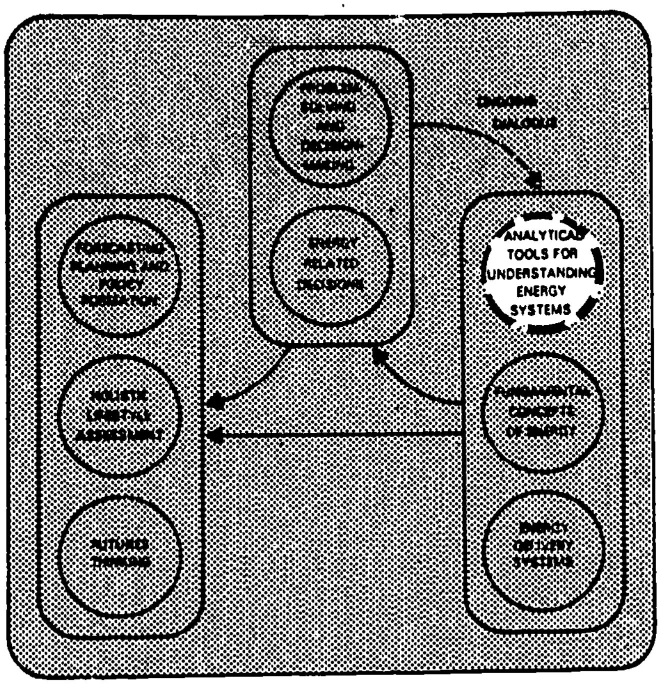
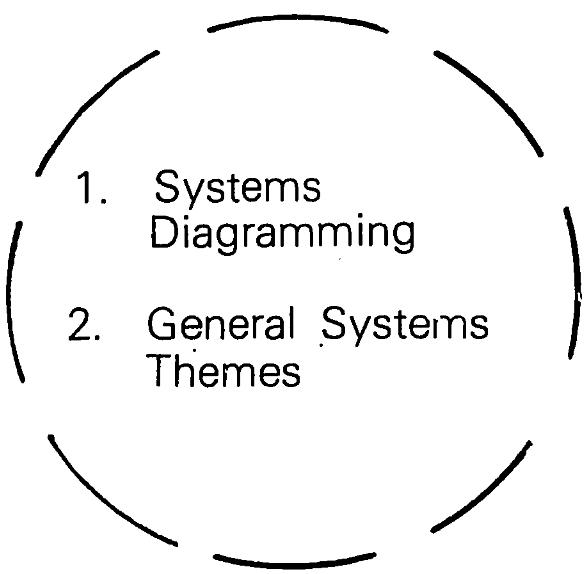
ANALYTICAL TOOLS FOR UNDERSTANDING ENERGY SYSTEMS



CONTENT MODEL FOR HIGH SCHOOL ENERGY/ENVIRONMENTAL EDUCATION

A systemic approach to learning about energy 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 energy systems.



Knowledge Components of ANALYTICAL TOOLS FOR UNDERSTANDING ENERGY SYSTEMS

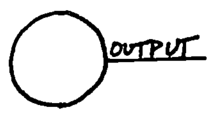
This area of the high school energy curriculum presents two tools that are useful in recognizing and describing patterns of systems and systems behavior.

1. SYSTEMS DIAGRAMMING

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

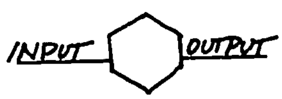
A set of symbols has been developed by H. T. Odum for diagramming the interactions of man and nature.[1] These symbols are based on the most common entities and activities found in all systems that process resources and utilize energy.

The symbols are representative of the following energy processes:



- sources of resources and/or energy

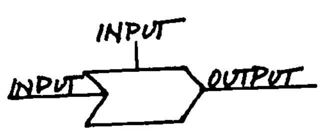
- production subsystem or photosynthesis activities



- consumer system using energy produced

- storages

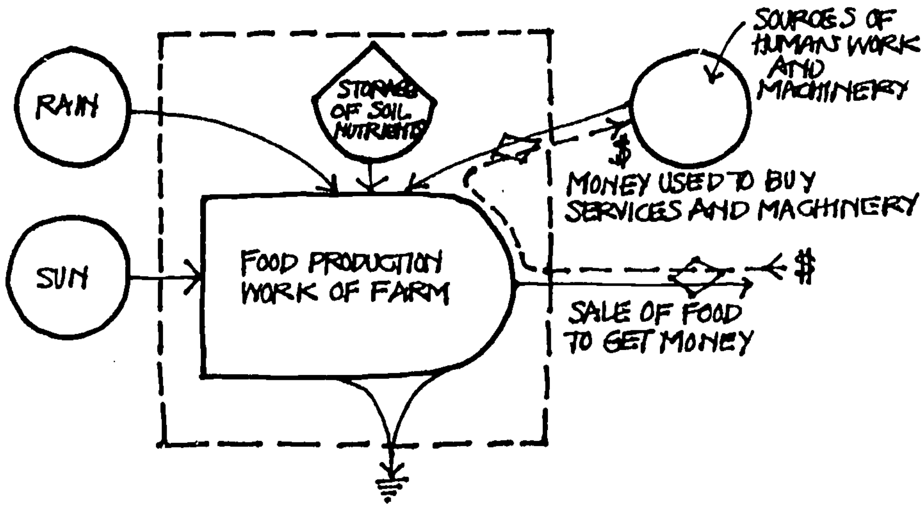
- energy sinks



- interaction of energies flowing along pathways

[1] 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 farm system can be shown as follows:



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2. 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."[2]

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.

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

The $\boxed{\text{purpose}}$ of the knowledge components of ANALYTICAL TOOLS FOR UNDERSTANDING ENERGY 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 man-environment interactions.

5. To demonstrate how general systems themes can be used as a tool for understanding energy in a holistic, systemic way.

6. To demonstrate how an understanding of systems can be used to describe and understand many types of energy/environmental phenomena.

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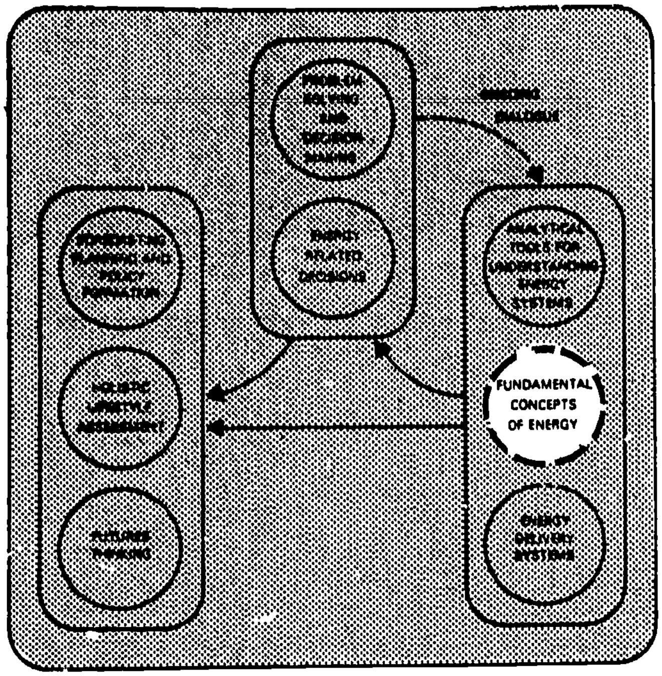
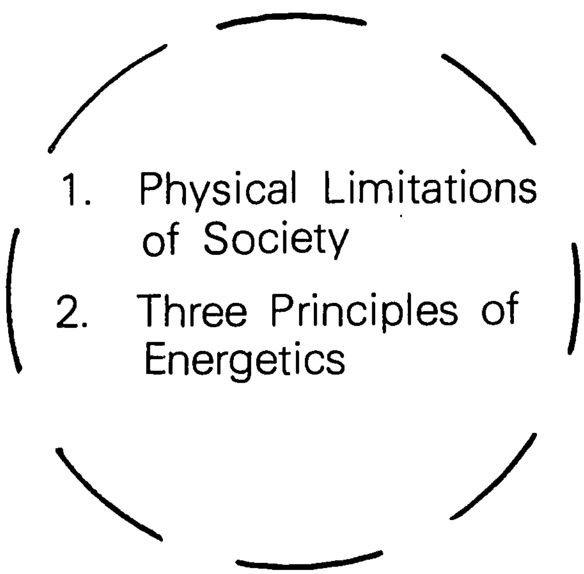
FUNDAMENTAL CONCEPTS OF ENERGY



CONTENT MODEL FOR HIGH SCHOOL
ENERGY/ENVIRONMENTAL EDUCATION

The FUNDAMENTAL CONCEPTS OF ENERGY are necessary to understand the behavior of energy as it flows through systems. These energy laws help establish a basis for a common sense approach to FUTURE PLANNING.



Knowledge Components of
FUNDAMENTAL CONCEPTS OF ENERGY

This area of the high school energy curriculum will explore three principles of energetics that are useful in considering energy questions.

1. PHYSICAL LIMITATIONS OF SOCIETY

The implications of principles of physical science on contemporary thinking about energy and energy-related matters to include:

a. The interplay between absolute principles and situational (or relative) principles in our thinking patterns

b. Worldview definitions and their development in individuals, institutions, and corporations.

2. THREE PRINCIPLES OF ENERGETICS [1]

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 as 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 <u>potential</u> energy and is still useful. Energy that has done work is degraded and is no longer useful at its <u>original</u> potential.

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[1] The first and second principles of energetics are closely equivalent to the first and second laws of thermodynamics.

[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.

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 <u>competition</u>. The application of this principle to mature systems that are in steady state with the resources of their environment (climax) generates cooperation.

[4]Ibid, p. 39.

The $\boxed{\text{purpose}}$ of the knowledge components of FUNDAMENTAL CONCEPTS OF ENERGY is:

1. To develop a philosophical basis for discussing the influence of physical limitations on society.
2. To define energy and explain the parameters of energy based upon the three principles of energetics.

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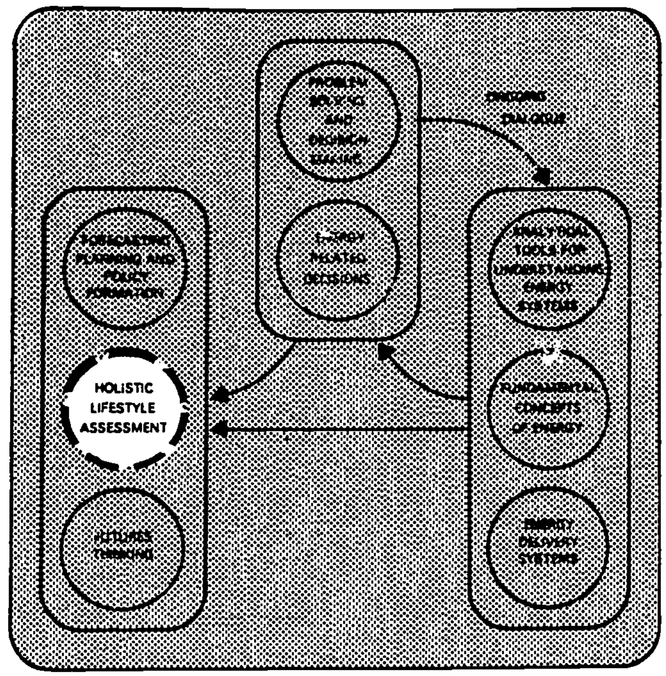
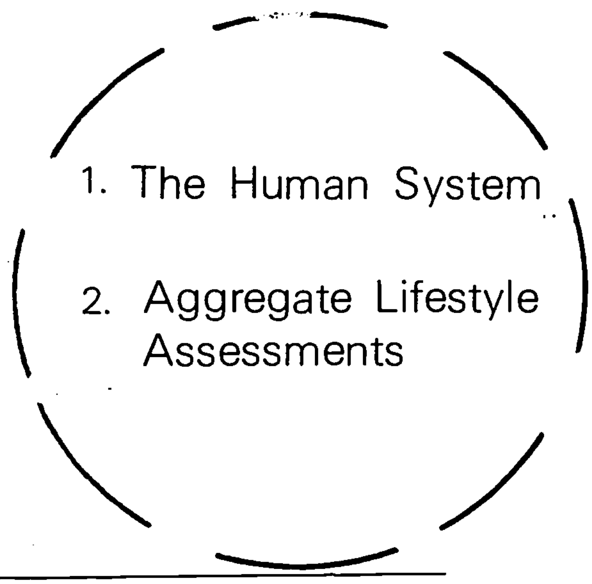
HOLISTIC LIFESTYLE ASSESSMENT



CONTENT MODEL FOR HIGH SCHOOL
ENERGY/ENVIRONMENTAL EDUCATION

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

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



This area of the high school energy curriculum will describe the human system, its needs and the impact of aggregate lifestyles on our energy 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 open 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 energy is 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
Curiosity and Knowledge	Schools, Libraries, Museums
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 characteristics 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 ASSESSMENTS

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 energy 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 energy terms.

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

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

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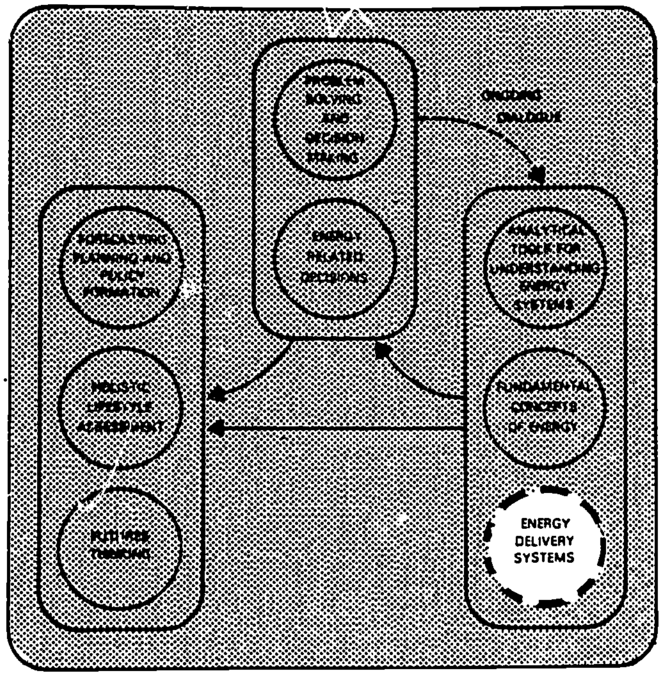
ENERGY DELIVERY SYSTEMS



CONTENT MODEL FOR HIGH SCHOOL
ENERGY/ENVIRONMENTAL EDUCATION

ENERGY DELIVERY SYSTEMS are the means to satisfy the demands of society. From exploration to end use, the processes of the delivery system "cost" energy. What remains after paying these costs is NET ENERGY.

A principle of energy conservation is to use energy products for tasks that require that specific ENERGY QUALITY.

1. Energy Resources
2. Delivery System Stages
3. Net Energy Analysis
4. Energy Quality
5. End Use

Knowledge Components of
ENERGY DELIVERY SYSTEMS

This area of the high school energy curriculum will explore several aspects of energy delivery systems as they relate to our individual/aggregate lifestyle decisions.

1. ENERGY RESOURCES

a. The primary energy 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 an energy resource is also a function of available technology and capital investment.

NON-RENEWABLE PRIMARY ENERGY RESOURCES	RENEWABLE PRIMARY ENERGY RESOURCES	
Petroleum	Solar	Radiant Solar Heat Photovolatic Conversion
Natural Gas	Hydrological	Fresh Water Hydroelectric
Coal	Oceanographic	Tidal Temperature Gradient
Fissionable Materials	Geothermal	Steam Heat
	Life Forms	Human Photosynthesis Forests
	Recyclable Waste	

b. Secondary or tertiary sources of energy can be classified as recycled energies from processes that are driven by either type of primary energy 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 energy 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 SYSTEM STAGES

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

STAGE	SAMPLE ENERGY DELIVERY SYSTEMS	
	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 chemist'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 the amount of energy 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 ENERGY) are used to account for energy losses during the delivery system processes.

Three types of energy losses are:

a. Degradation: the premature degradation of energy such as gasoline losing potency, batteries losing charge

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 or high-sulfur coal

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. 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. ENERGY QUALITY

Energy quality is a measure of substance's potential to do work. Higher quality energies such as electricity have had a lot of "work" done to them to upgrade them, making them more flexible.

> "The diversity in the work which can be done by 1 kJ of energy from fossil fuel is not the same as can be accomplished by 1 kJ of electrical energy. In fact, 1 kJ of electrical energy is equivalent to about 3.8 kJ of energy from fossil fuel."[4]

HOW DO WE USE HIGH QUALITY ENERGY?

Energy products should be used for tasks that require its specific energy quality. This is a principle of energy conservation.

> Higher grade energy such as electricity is wasted on an operation with a low quality requirement: opening cans, carving meat.

[4] Loose, K. D., Six Energy System Concepts, Paper presented at Eighth Annual Symposium or Systems and Education, Far West Laboratory for Educational Research and Development, San Francisco, 1976.

5. END USE

End use is the consumption of energy products. It is the process which satisfies the basic human needs described in HOLISTIC LIFESTYLE ASSESSMENT.

These "energy products" are of two types:

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

b. Indirect: all other energy forms that are required in the delivery systems to make the direct energy 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 involved.

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

1. To describe primary and secondary energy 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 energy delivery system from exploration to end use.

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

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

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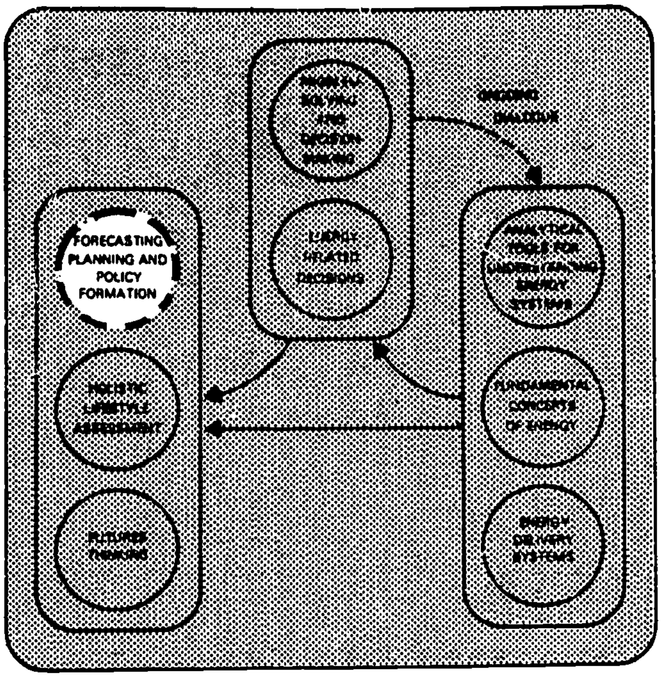
FORECASTING, PLANNING AND POLICY FORMATION



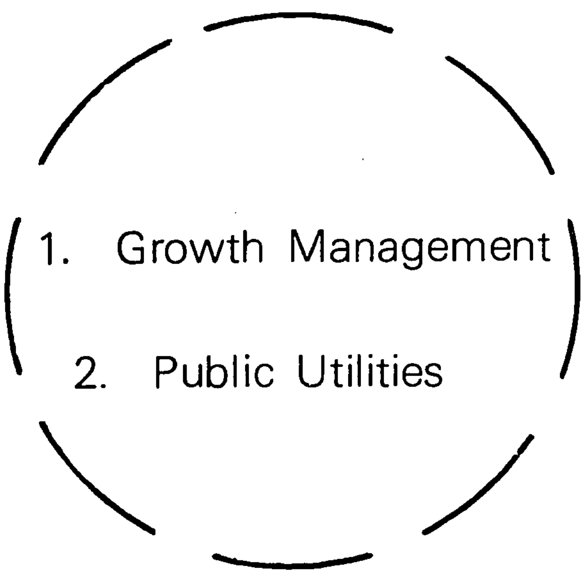
CONTENT MODEL FOR HIGH SCHOOL
ENERGY/ENVIRONMENTAL EDUCATION

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 to change the direction of the planning.



Knowledge Components of
FORECASTING, PLANNING AND
POLICY FORMATION

This area of the high school energy curriculum will describe the idea of planned growth in business and government and will explore 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

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.

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

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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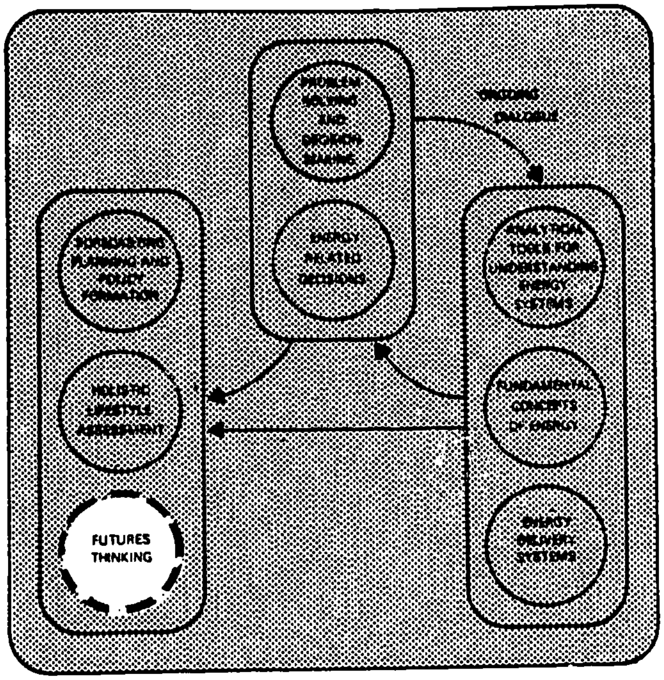
FUTURES THINKING

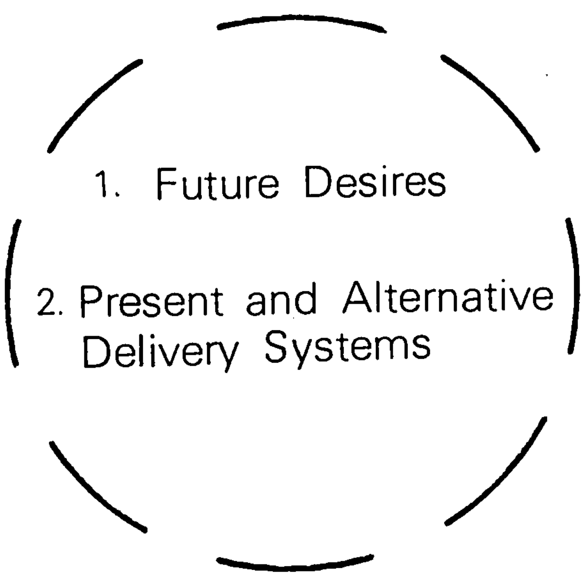


CONTENT MODEL FOR HIGH SCHOOL ENERGY/ENVIRONMENTAL EDUCATION

FUTURES THINKING examines 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 high school energy curriculum would address student questions about future desires and the ability of the present energy 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
- concept 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 than 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 techology 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]

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[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 natural, human and currency resources required for the goal.
	Access to primary means of production for the fulfillment of the goal; most desires require a variety of technologies and producers.

- growth management 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 ENERGY DELIVERY SYSTEMS?

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

- Determine present energy consumption rates and patterns

WHAT ARE THE ALTERNATIVES TO THE PRESENT ENERGY 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 <u>can</u> the future be?" in terms of merely extending available processes, making minimal changes.	PROCESS EVALUATION APPROACH
• A more optimistic, visionary approach asks "What <u>should</u> 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 <u>begin</u> 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, energy production and consumption.

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

3. To encourage voluntary decision-making that synchronizes energy consumption/lifestyle with available means of energy production.

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 energy delivery systems.

FUTURES THINKING

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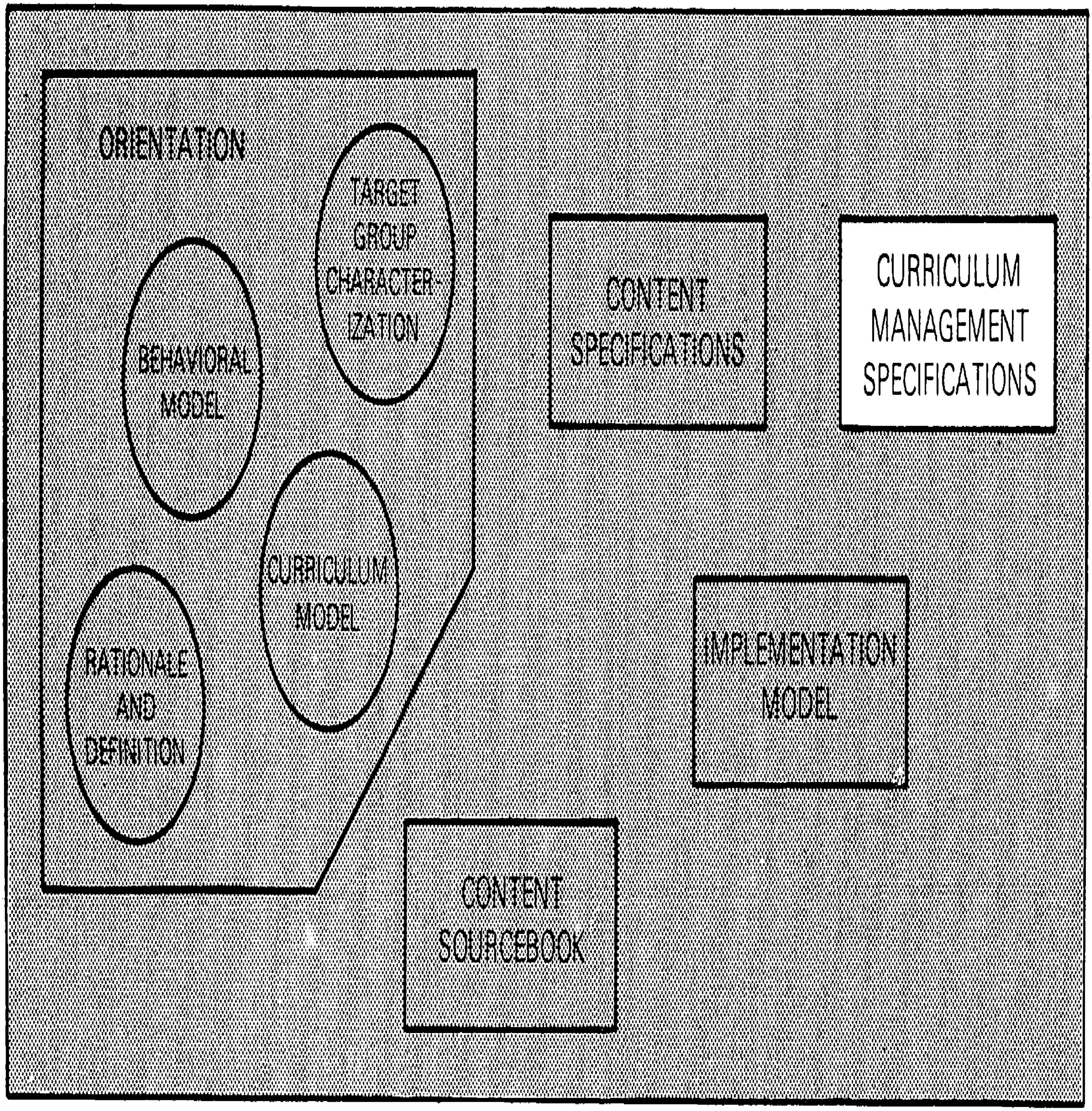
Curriculum
Management
Specifications

THE HIGH SCHOOL ENERGY/ ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL



ENERGY/ENVIRONMENTAL EDUCATION
TEACHER TRAINING MODEL

INTRODUCTION

The Curriculum Management component of the Energy/Environmental Education Teacher Training Model introduces specifications for teachers to purpose, plan, implement, and evaluate a high school energy course. The specifications delineated herein will become the basis for identifying or developing instructional resources (techniques, strategies) which teachers can use to assist students in acquiring desired knowledge, skills and attitudes competences consistent with the energy/environment Curriculum Model.

As a general instructional management model, then, these specifications describe the arrangements by which teachers can:

- select, develop, and implement an energy-focused 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 energy/environmental awareness

Part One will define the four components of the curriculum management sequence and describe the perspectives and values that act as guidelines for operationalizing these components.

Part Two will detail the arrangements made by the teacher to purpose, plan, implement and evaluate an energy-focused environmental education curriculum.

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PART ONE

THE INSTRUCTIONAL MANAGEMENT SEQUENCE

A. DEFINITION

The instructional management sequence consists of four interrelated components which describe the steps or operations associated with purposing, planning, implementing, and evaluating a high school energy/environmental curriculum compatible with the Curriculum Model described in the Orientation section. These components are described as follows:

PURPOSING	The teacher establishes the parameters within which learning is to occur by developing student learning objectives which are consistent with the behavioral competences embodied in or implied by the energy/environment Curriculum Model and which are compatible with the needs, abilities, and preferences of his/her students.
PLANNING	The teacher sets the conditions under which learning will occur by:

- selecting an interrelated, essential set of energy/environment concepts and processes (see Content Specifications) as topic entry points
- selecting or developing curriculum materials which address specific energy/environment phenomena, problems, and issues in which these concepts and processes are embedded
- selecting appropriate instructional/learning arrangements which enable students to identify and understand these concepts in exploring real energy/environment phenomena and problems
- organizing and sequencing student learning objectives, curriculum materials, and other energy/environmental learning resources into meaningful instructional units or lessons
- locating and selecting available resources which facilitate both instruction and learning.

IMPLEMENTING

The teacher carries out planned instructional/ learning arrangements by

- utilizing specific curriculum materials and learning resources in order to convey the students energy/environmental concepts and processes
- studying with students relevant energy/ environmental phenomena, problems, and issues through case study analyses, problem discussions, simulations, field trips, and other learning activities
- applying some general strategies for ensuring that the energy/environment curriculum achieves desired student learning and motivation objectives (see Behavioral Model, Orientation section)

EVALUATING

The teacher assesses the students' progress towards achieving learning objectives and makes suitable adjustments in the instructional/ learning arrangements to facilitate such progress. This is accomplished by:

- selecting or developing methods and instruments for evaluating instructional/learning arrangements
- assessing key aspects of the energy/environment curriculum
- assessing key aspects of the purposing, planning, and implementing sequence.

B. ORGANIZING VALUES

The specifications outlined in this curriculum management sequence are designed with the following perspectives or values as guidelines:

- That the learner must be the central focus of the energy/environmental education curriculum.

  This means, essentially, that the energy/environmental curriculum should be organized, first, around the needs and abilities of the learner <u>and</u> the resources that facilitate the development of desired competences in the learner and, second, around the instructional arrangements that facilitate the learner's utilization of learning resources to attain desired competences.

- That the learning resources and instructional arrangements should help to develop higher levels of energy/environmental awareness in the learner by encouraging transdisciplinary inquiry rather than fostering a reliance on "experts" in special knowledge areas.

- That the learning resources and instructional arrangements should attempt to provide a balance between primary information acquired through real or simulated experiences and secondary or tertiary information acquired through reading, lectures, and discussions.

- That the learning arrangements should be flexible and responsive to the learner rather than oriented exclusively to the subject discipline of the teacher.

- That the learning and instructional arrangements should focus on the synthesis and organization of information from a variety of fields rather than on information or perspectives specific to a given field or discipline.

  For example, learning resources should help the learner identify and analyze economic, political, social, technological, etc. information which is pertinent to defining and understanding an energy/environmental problem as a system. Thus, the emphasis would be on the acquisition of a transdisciplinary knowledge base.

- That learning is a lifelong proposition which goes on long after a specific set of learning or training experiences has been terminated.

Thus, although the specific learning objectives devised by teachers for an energy/environment course will likely address relatively short-term objectives (see Figure 1), the learner's understanding of energy concepts and processes as applied to energy problems, and issues, is expected to continue developing after formal instruction ends--assuming, of course, that the learner finds value in and continues to apply in some fashion the knowledge and skills acquired during the course.

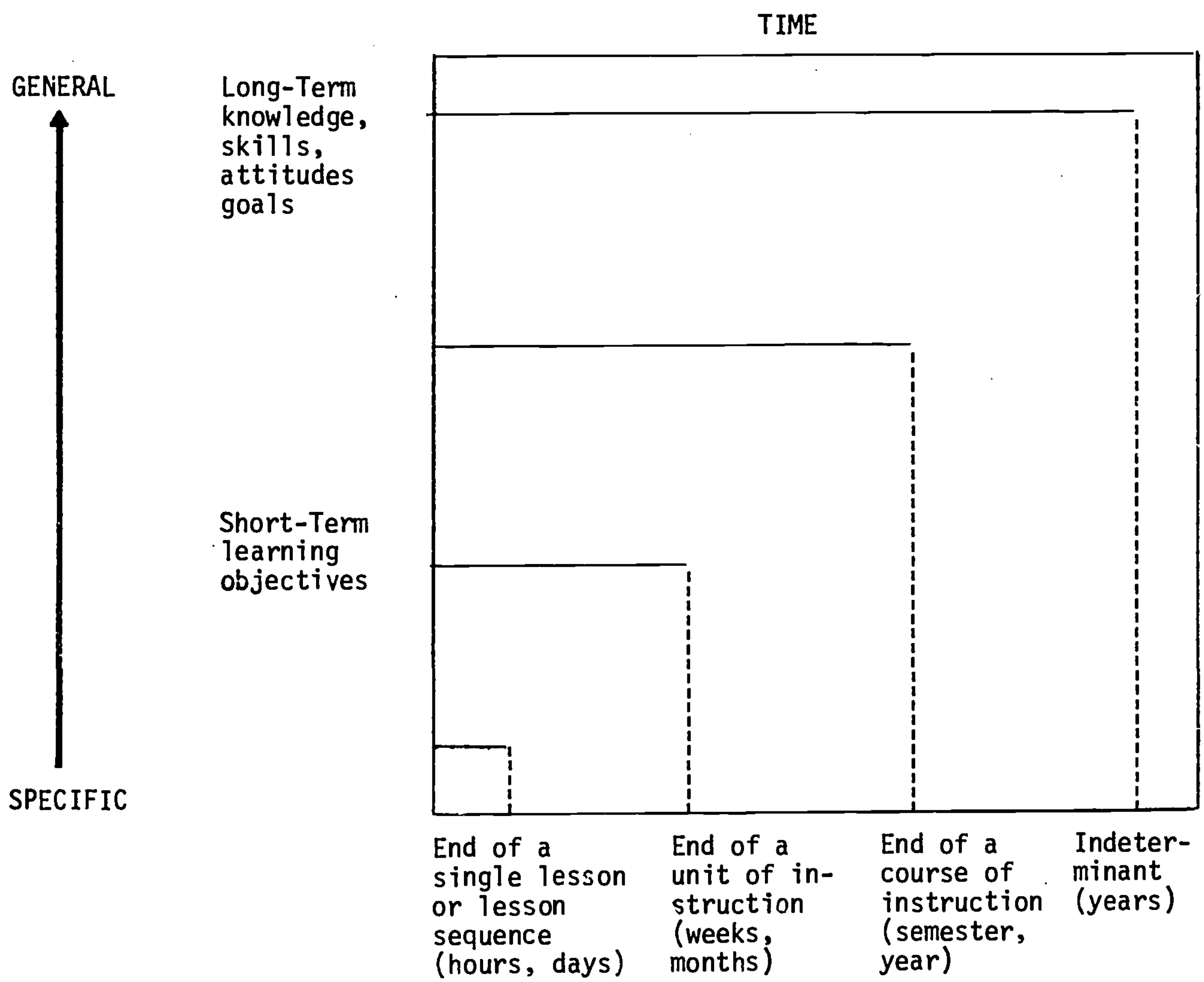


Fig. 1. Display of Potential Energy Awareness Learning Goals and Objectives Over Time

PART TWO

THE COMPONENTS OF CURRICULUM MANAGEMENT

A. PURPOSING

1. <u>Set student learning objectives</u> by expressing desired student learning outcomes in terms of short-term (lesson, unit, course) behavioral or performance objectives which are derived from the planned energy/environmental curriculum content.

   a. Generate <u>end-of-course objectives</u>, the desired student knowledge, skill, and attitude outcomes <u>to be achieved at the end of the course of instruction</u> in energy.

   b. Derive tentative <u>lesson and instructional unit objectives</u>, the desired student knowledge, skill, and attitude outcomes <u>to be achieved at the end of single lessons and lesson sequences</u>, from the end-of-course objectives and from the requirements of selected components and subcomponents of the energy/environment curriculum.

   c. State both end-of-course and lesson/unit objectives in behavioral terms. To do this, devise a statement which has the following components:

      - Describes the competences the student will be able to demonstrate or the task the student will be able to do.
      - Describes the conditions that will be imposed on the student in demonstrating the competence or in carrying out the task, i.e., the information, materials, and procedures that will be used.
      - Describes the criteria that will be used to determine that the student has successfully demonstrated the competence or accomplished the task, i.e., states the accuracy, quality, or quantity required for acceptable performance.

d. Examples of lesson or unit and end-of-course objectives which are stated in behavioral terms according to the criteria above are as follows:

Lesson or Unit:

When presented with three different proposals for solving an energy conversion and utilization problem, the student will be able to classify each one according to the type of worldview it represents and state at least one implication of each worldview on aggregate (societal) lifestyles.

End of Course:

When presented with an energy conversion and utilization case study, the student will be able to characterize the situation in terms of its system's components and interactions using at least five general systems themes and five diagramming symbols.

2. <u>Assess student learning objectives</u> by evaluating specific energy/environment curriculum learning objectives to ensure adequacy and relevance. This can be done by applying the following criteria:

- Consistent with the general energy/environment learning objectives presented in the <u>Content Specifications</u>
- Encompasses the specific educational or learning needs of the students for which they are designed (classroom, school, district)
- Addresses the broad range of energy/environment concept and process areas covered in the <u>Content Specifications</u>
- Stated in behavioral terms so that both teacher and students will be able to monitor students' progress in developing energy/environmental awareness
- Contributes to or is compatible with the general curriculum objectives or goals of the classroom, school, district
- Appropriate to the developmental or ability <u>and</u> interest levels of the students
- Attainable within such constraints as time available for instruction, and availability of learning resources

B. PLANNING

1. Organize the energy/environment concept and process areas of the Content Specifications into a course learning trail compatible with the teacher's interests and subject-matter preparation and appropriate to the students' abilities, needs, and interests.

> For example, a Social Science teacher might devise a course trail which emphasizes learning components under PROBLEM-SOLVING, FORECASTING, PLANNING, and POLICY FORMATION, and FUTURES THINKING; whereas a Science teacher might wish to select a course trail emphasizing learning components under SYSTEMS ANALYSIS, NET ENERGY, and ENERGY QUALITY.

Whatever emphasis is chosen, the student learning trail selected should consist of an essential set of concepts and processes representative of the entire Content Specifications. This should ensure that the course content presents a holistic picture of energy and energy/environmental problems and issues.

2. Select example phenomena, problems, issues which effectively illustrate the energy/environment concepts and processes in the selected student learning trail. Some useful steps to accomplish this are:

   a. Select real (local, state, national, or international) energy/environmental phenomena, problems, and issues.

   b. Select information, data, study activities from available local resources and from the resources found or described in the Content Sourcebook.

   c. On the basis of students' abilities and interests, select an appropriate balance between learning energy/environmental phenomena and learning energy problems.

      - Learning energy phenomena emphasizes phenomenological, interactive relationships between and within energy/environmental systems and sub-systems. For example, students would explore energy case studies in order to develop their understanding of the various types of renewable and non-renewable resources of energy; or to develop their understanding of the processes by which these energy sources are extracted and converted into end use in homes or industry.

      - Learning energy problems and issues emphasizes both the interactive and conflict relationships between co-equal and nested energy/environmental systems. For example, students would explore energy case studies in order to develop their understanding of the implications of pursuing "hard technology" (e.g., nuclear fission) solutions to the energy crisis versus "soft technology" (e.g., solar, wind power) solutions; or students would engage in simulation exercises to explore the processes and conflicts involved in developing, proposing, and enacting legislation which addresses energy problems.

3. Select appropriate instructional/learning arrangements for conveying the energy/environmental content. Some steps to doing this are:

   a. Select appropriate discovery or directed strategies for teaching energy/environmental concepts and processes.

      - Discovery-inductive strategy moves from the particular to the general where students explore an energy/environmental concept by discovering common features with which to group observation and discussion items or data associated with the concept.

      - Discovery-deductive strategy moves from the general to the particular where students search for applications or new examples of a rule or set of attributes that is associated with an energy/environmental concept.

      - Directed-inductive strategy moves from the particular to the general where the teacher directs instruction step by step from specific examples or critical attributes of an energy/environmental concept to the general meaning of the concept.

      - Directed-deductive strategy moves from the general to the particular where the teacher defines an energy/environmental concept and moves to specific examples or critical attributes.

   b. Select appropriate modes of inquiry for dealing with energy/environmental phenomena, problems, issues.

      (1) Generalizing mode emphasizes the use of questions and learning exercises that proceed in three phases and lead to the development of a main idea or generalization about energy.

         (a) Phase One -- introductory activities designed to clarify the energy/environmental phenomenon, problem, or issue.

         (b) Phase Two -- planned sequences of developmental activities in which needed energy/environmental concepts and data are utilized in order to move toward a main idea or generalization about energy.

         (c) Phase Three -- activities designed to provide for a synthesis of ideas into one main idea about energy (in the students' own words) and an evaluation and double-checking of the soundness of the main idea with real data associated with the energy/environmental phenomenon, problem, or issue.

(2) Integrative mode emphasizes the bringing together of the special features of energy/environmental phenomena, problems, issues, e.g., economic conditions, basic or perceived needs of various people, availability of renewable or non-renewable resources, methods for extracting and convering resources for needed end use.

(3) Decision-making mode emphasizes the making of judgments or decisions about events, activities, actions, or proposals for action that are associated with energy/environmental problems and issues.

c. Select appropriate strategies for utilizing inquiry modes dealing with energy/environmental phenomena, problems, and issues.

(1) Interviews: To gain firsthand information from individuals who have specific or expert knowledge about energy/environmental phenomena, problems, issues.

(2) Field Trips: To gain a firsthand view of energy extraction, conversion, use, and misuse by observing people at work--in business and industrial activities, farming and processing of produce; plants and animals in natural or man-made settings, etc.

(3) Demonstration: To impart information about energy directly or to illustrate the application of a skill (e.g., general systems analysis of an energy/environmental phenomenon, lifestyle analysis of an individual's or group's use of energy).

(4) Role-Playing: To enable students to experience energy/environmental situations or problems that arise in daily living in order to clarify value positions, to gain insight into people's attitudes, and to practice decision-making.

(5) Simulation exercises or games: To enable students to engage in simplified models of real activities related to energy/environmental phenomena and problems, e.g., energy conversion and use, allocation of natural resources, urban and land use planning, corporate or governmental decision-making regarding energy, etc.

d. Design energy-focused questioning/discussion strategies which utilize a wide range of congitive or inquiry processes.

(1) Recalling and observing: To marshal the ideas students are to use in a given learning situation or activity. Observing can occur directly through seeing and touching, and indirectly through films, recordings, books, and other media.

(2) Comparing/contrasting and classifying: To have students organize information that has been recalled or collected by various methods (observation, reading, interviews, etc.).

(3) Interpreting: To have students translate, state, or explain the meaning of whatever energy/environmental data is being used.

(4) Generalizing: To have students abstract the central or main idea to a level which covers the available facts of the case and which might cover other similar cases.

(5) Inferring: To have students read between the lines or draw an implication.

(6) Hypothesizing: To have students formulate a proposition that can be tested by gathering additional data.

(7) Predicting: To have students forecast, prophesy, or anticipate (make educated guesses about) what might happen.

(8) Analyzing: To have students break down energy/environmental phenomena or problems into parts, components, sub-systems, relationships, etc.

(9) Synthesizing: To have students put parts, sub-systems, etc., together into more integrated, meaningful wholes.

(10) Evaluating: To have students make judgments of merit, worth, or value using defined criteria.

e. Select suitable values analysis and clarification strategies for dealing with energy/environmental problems and issues.

   (1) Rational values analysis involves phases or steps, closely related to those included in reflective-thinking or problem-solving. They begin with the clarification of an energy/environmental issue or problem, move to the collection and organization of relevant data, and finally move to the making and checking of a conclusion of terms of its consistency with basic values or principles.

   (2) Identifying values in topics under study begins with identification of facts and main reasons for the energy/environmental event under study, then moves to inferring values from the stated reasons, and finally moves to personalizing the analysis by stating what students would have done and what values might be inferred from these statements or positions.

   (3) Values clarification involves helping students clarify their own values regarding an energy/environmental issue or problem by accepting their responses, encouraging honesty and diversity in response, and avoiding questions or comments that limit thinking or prevent maintaining of an open atmosphere.

f. Select an appropriate point-of-entry or frame-of-reference for introducing energy/environmental phenomena, problems, or issues to students.

   (1) Top-down approach -- the entry point is an intellectual understanding of concepts and processes (energy quality, appropriate technology, complex decision-making) which are then applied to redefining and analyzing energy/environmental situations, problems, issues.

   (2) Through-the-middle approach -- the entry point is the students' feelings (gut reactions) about a situation which affects their perceptions of need or motivates their interest. Hence, it may become important to apply self/other referencing tools (worldview analysis, values clarification) in order to clarify students' values and the values of these in the energy/environmental situation being studied.

   (3) Bottom-up approach -- the entry point is through accumulated information about the energy/environmental situation, obtained from careful observation and measurement, which has been compiled by the student or, more likely, by others (via technical reports, newspapers, books, magazine articles, films, slides, tapes, etc.).

4. Organize instructional/learning arrangements and resources into vertical and horizontal components

a. Horizontal component -- organization based on the abilities and preparation of students (i.e., their present level of knowledge, skills, attitudes, interests, values, social development) and the difficulty or complexity of the learning tasks.

b. Vertical component -- sequencing over time according to some logical order to presentation and the compatibility of learning units or segments.

c. General criteria for vertical and horizontal ordering:

- Should move students gradually from simple learning objectives to more complex learning objectives.

- Should move students gradually from simple materials and single sources of information to more complex materials and multiple sources of information.

- Should move gradually away from an emphasis on teacher direction and teacher evalution to an emphasis on student initiation and self-evaluation.

5. Analyze and allocate available resources which facilitate instructional/learning objectives

   a. Survey available materials, media, resource persons, community resources, etc., which appear to describe, elaborate, or otherwise illustrate the energy/environmental curriculum content.

   b. Analyze and select interesting or potentially useful materials, media, etc., in terms of their potential for achieving student learning objectives.

   c. Sequence and Schedule the use of resources according to the vertical and horizontal organization described previously.

C. IMPLEMENTING

1. Apply planned instructional/learning arrangements (see Section B,3)

   a. Apply instructional/learning arrangements which have been organized into various types of learning experiences:*

      (1) Focusing experiences help students connect energy/environmental concepts or generalizations to their own experiences, connect or relate new learning units or lessons to those that have preceded it, and arouse interest and motivate student involvement in the new learning activity.

      (2) Data-gathering and processing experiences enable students to explore resources and obtain information pertinent to the energy/environmental concepts or problems being studied, and develop student competencies in quantifying, recording, organizing, and communicating data and information.

      (3) Conceptualizing experiences assist students to formulate and/or broaden their understanding of an energy/environmental concepts or problems. Such experiences involve translating data from tabular and graphic form and interpreting, extrapolating, and generalizing data. These skills may be developed through questioning, discussing, demonstrating, and investigating in the classroom or on field trips.

      (4) Confrontation experiences are those that confront the students with discrepant information about energy/environmental events. Such experiences may be contrived by the teacher or may arise naturally when students obtain data that are in real or apparent conflict with their mental models of or attitudes toward some aspect of their environment.

      (5) Critical investigation refers to investigations or case studies that are carried out by the students to explain the discrepant or related energy/environmental phenomenon, issues, or events.

      (6) Evaluation of experiences encourage students to evaluate their perceptions, data, and conceptual understanding. Evaluation in this context involves making personal judgments about the value of ideas, solution strategies, methods, materials and the like.

*Adapted from Science Framework for California Public Schools.

(7) Summarizing experiences enable students to summarize and apply what they have learned and to set it into a larger framework. These may involve discussions that bring out the tentative nature and limitations of newly gained energy/environmental concepts, independent study activities, activities that lead into the next learning unit or lesson, or self-evaluation activities that assess the extent to which learning objectives have been attained.

b. Apply question/discussion strategies* in characterizing energy/environmental phenomena and identifying and devising solutions to energy problems.

(1) In identifying energy problems, discuss:

- What is the norm? (interpreting, generalizing, inferring)
- How do you look for problems? (generalizing, analyzing, synthesizing)
- How do you evaluate the quality or impact of various energy/environmental factors? (synthesizing, evaluating)
- How do you gather and organize data? (classifying, generalizing)
- How do you develop an energy/environmental problem statement? (analyzing, synthesizing)

(2) In discussing what the technological possibilities are for solving energy-focused environmental problems, identify:

- What is technologically possible? (synthesizing, evaluating)
- What can be done in this case? (synthesizing, predicting, evaluating)

*Adapted from Schafer, R., Ecoaction (unpublished paper).

2. <u>Utilize appropriate resources</u> for conveying the energy curriculum concepts via energy/environment problem discussions, case studies, and other learning activities/exercises.

- For example, utilize general systems themes and diagrammatic symbols in an energy phenomenon/problem case study analysis

3. Utilize problem-identification, problem-solving, and complex decision-making processes for focusing and applying energy/environment curriculum content in classroom discussions, work assignments, participation activities (e.g., role-playing, simulation games, etc.).

   a. Problem identification

      (1) Recognize problem and/or issues

      (2) Define the problem

      (3) Collect related facts and data

      (4) Organize data into meaningful information

      (5) Analyze information

   b. Problem-solving

      (1) Identifying or generating alternative solutions

      (2) Selecting "overt" criteria to evaluate the alternatives

      (3) Applying the criteria to select the most desirable alternative(s)

   c. Complex decision-making

      (1) Comprehending the decision-making space, i.e., complex decisions affect multiple interests, are largely intuitive, require assumptions about the nature of the decision environment, involve several kinds of "costs," and require good timing

      (2) Initiating the decision process involves perceiving a need for change, diagnosing the problem, defining aims, identifying affected interests and their relative urgencies, and determining how goals attainments will be gauged

      (3) Selecting and utilizing elementary decision and evaluation models, e.g., single and multistage, focused objectives and "muddling through" types, open and closed loop models, satisfying and optimizing approaches

4. <u>Apply general strategies for implementing the energy/environmental curriculum relevant to attitude, skills and knowledge objectives</u>

a. <u>Attitude objectives</u>

(1) Present energy/environmental problem dilemmas which require that students make and justify choices between opposing sets of conditions

(2) Present energy/environmental problems or values issues which contradict students' value positions and force them to seek new information and to reintegrate their values positions in order to accommodate or resolve the conflict.

(3) Present learning activities/exercises that are appropriate to students' levels of preparation and abilities so that they can "experience success" in analyzing and/or developing solutions to energy/environmental problems.

(4) Present energy/environmental awareness activities which are geared to students' interests and to available (local, school and community) resources in order to enhance the meaningfulness of the learning experience.

b. <u>Skills objectives</u>

(1) Present energy/environmental concepts, phenomena, and problems which enable students to utilize a wide range of critical thinking and inquiry processes (see Section B, 3b).

(2) Introduce increasingly complex energy/environmental concepts, phenomena and problems to enable gradual mastery of the use of the analytic (e.g., systems themes) and self/other referencing tools (e.g., values clarification).

(3) Combine discussions and demonstrations with practice opportunities (activities, exercises) to develop students' mastery of analytic and self/other referencing tools.

(4) Provide alternative methods of learning by presenting students with energy/environmental phenomena or problems which require them to learn and apply analytic and referencing tools in order to develop explanations, to develop possible or alternative solutions, to explore attitudes and values, etc.

(5) Encourage students to identify and define energy/environmental problems on their own and assist them in analyzing and in generating alternative solutions to these problems.

c. Knowledge objectives

(1) Develop instructional lessons and activities which convey selected energy/environmental concepts and processes, and which demonstrate the applicability of the analytic and referencing tools.

(2) Sequence the energy/environmental instructional lessons from simple to more complex and administer according to the preparation and abilities of the students.

(3) Emphasize the interconnections and interrelationships between energy concepts and processes and energy phenomena, issues, and problems.

(4) Encourage student interaction to share understandings and ideas related to energy/environmental issues.

(5) Present students with information which challenges or conflicts with their knowledge/comprehension base and forces them to acquire and reorganize new information.

(6) Provide exercises/activities which aid students in synthesizing lower order energy/environmental concepts and relating them to broader, higher order concepts, generalizations, and principles.

(7) In selection and sequencing energy problems and issues:

- present examples about which students have had some prior knowledge, then gradually introduce less familiar examples,

- break down complex problems and issues into smaller subcomponents, then gradually reassemble into larger (more complex) wholes.

d. Examples of a fusion of attitudes, skills, and knowledge objectives

(1) Present learning exercises (e.g., case studies) which require that students analyze the implications of their present lifestyle (basic and perceived needs) and career aspirations in real energy terms (energy consumption, waste, etc.).

(2) Present decision-making tasks which require that students devise tentative proposals for satisfying their future desires which are compatible with a synchronicity between energy consumption/conservation and lifestyle/career choice.

D. EVALUATING

1. Develop plans for evaluation of instructional/learning arrangements

   a. Include formative and summative evaluation phases:

      - Formative evaluation occurs during instruction to obtain ongoing feedback for both the student and teacher on student performance and any learning problems.

      - Summative evaluation occurs at the end of a lesson, unit, or a specified time period to assess attainment of learning objectives.

   b. In evaluating each of the phases (formative, summative), include both subjective-informal techniques and objective-formal techniques as needed.

      - Subjective-informal techniques include: teacher observation, group discussion, group interviews, individual interviews, logs, diaries, checklists, rating sheets, anecdotal records, and examination of students' work.

      - Objective-formal techniques include: criterion-referenced (teacher-made) tests, rating scales, and inventories of attitudes and values.

      - A combination of these techniques can be used to evaluate various learning objectives as shown in the following summary:

Attitude Objectives	Discussion Observation Reating Devices Inventories Anecdotal Records
Skills Objectives	Criterion-referenced tests Samples of work Observation Checklists Charts Interviews Discussion Rating Devices
Knowledge Objectives	Criterion-referenced Tests Samples of work Checklists Observation Interviews

- Criteria for selecting or developing measurement instruments and techniques can include the following:

  Usefulness of the instrument or device in providing the information or evidence needed to evaluate learning (knowledge, skills, and attitudes) objectives.

  Validity of the instrument or device such that it assesses outcomes of instruction that are in fact directly related to what is being taught.

  Appropriateness of the instrument or device in terms of suitability in assessing various types of planned learning outcomes.

  Practicality of the instrument or device in terms of ease of administration and data processing.

c. After specifying learning objectives, prepare a table of specifications that brings together the competences (knowledge, skills, attitudes) to be developed and the energy content, units, and learning activities to be used in developing them (see Table One).

   (1) Down the lefthand side of the table are listed the knowledge, skills, and attitudes learning-step objectives.

   (2) Across the top of the table are listed the component (sub-sections) of the energy curriculum unit (section being taught.

   (3) Within the cells of the table are listed the instruments and techniques which are to be used to assess students' attainment of the learning-step objectives associated with each energy content subsection.

   (4) The table of specifications can be prepared in three phases:

   - Phase One: Construct the lefthand (learning-step objectives) and top (energy unit sub-section) components.

   - Phase Two: Decide on ways to collect the data and select or devise appropriate instruments using the suggested "types" lists in D, 1b.

   - Phase Three: Construct, try out, and revise instruments or devices based on end of unit (section) results.

Table One

Specifications for Evaluating the Attainment of Energy Curriculum Content Learning Objectives

Learning-step objectives	Energy curriculum unit (section) components			
	A.	B.	C.	etc.
Knowledge				
a.	(instruments &			
b.	techniques for			
c.	evaluating the			
d.	attainment of			
etc.	objectives)			
Skills				
a.				
b.				
c.				
d.				
etc.				
Attitudes				
a.				
b.				
c.				
d.				
etc.				

2. Evaluate the various areas of the energy curriculum by providing answers to the following questions:

   a. How can the basic learning resources be improved or better utilized?

      - The Content Sourcebook
      - Audio-visual resources, printed materials, community resources

   b. How can the student learning objectives be made more explicit and appropriate?

      - Knowledge objectives
      - Skills objectives
      - Attitudes objectives

   c. How can the structure or organization of the energy/environmental curriculum be improved?

      - Vertical organization
      - Horizontal organization

   d. How can the structure or organization of the learning environment be improved?

      - Organizing for individual or group instruction
      - Teacher directed or student directed activities.

   e. How can the variety and use of teaching strategies be improved?

      - Discovery and directed strategies
      - Modes of inquiry
      - Strategies for utilizing inquiry modes
      - Questioning/discussion strategies utilizing cognitive or inquiry processes
      - Values analysis and clarification strategies

   f. How can the evaluation instruments or devices be improved?

3. Complete the cycle for evaluating student performance and performance objectives (see Figure 2)

   a. Select, compose, and order lear-ing objectives

      (1) Generate specific learning objectives and express in behavioral terms

      (2) State desired knowledge, skill, attitude outcomes of a single lesson, lesson sequence, or course of instruction

      (3) State what the student must do to confront, practice, and incorporate competences into total action pattern

      (4) Describe the conditions under which the student is expected to exhibit the competence

   b. Pre-assess students

      (1) Diagnose learners to determine the feasibility of learning objectives

      (2) Adjust learning objectives to make them consistent with learners' abilities and interests, and therefore achievable

   c. Generate teaching strategies in relation to objectives

      (1) Consider data relevant to students' abilities and interests, available instructional materials and other resources, teacher's own experience and knowledge of energy/environmental curricula content and instructional/learning arrangements which are compatible with the above considerations and which are likely to facilitate students' achieving the energy/environmental curriculum learning objectives.

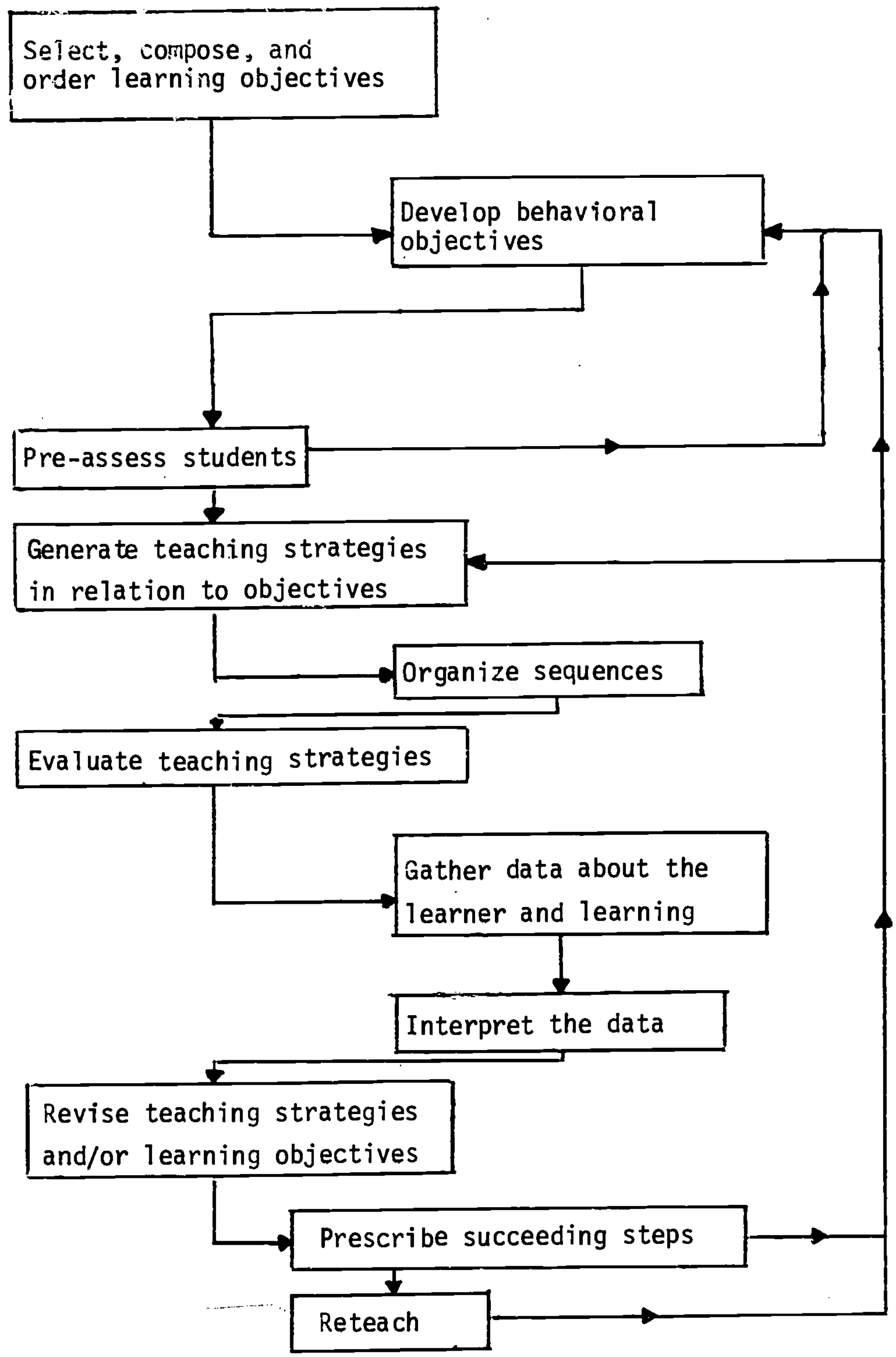
      (2) Organize learning sequences in a manner that:

         - Provides for a graduated increase in the complexity of energy/environmental concepts, problems, issues, case studies, and other learning activities according to the sophistication of the students.

         - Provides for individual student differences.

         - Provides timely feedback of results to the teacher and students.

Fig. 2. Cycle for evaluating student performance based on attainment of learning objectives*



*Adapted and synthesized from Popham (1965) and Costa (1968)

d. <u>Evaluate teaching strategies</u>

(1) Evaluate the effectiveness and efficiency of instruction relative to the students' achieving the energy/environment lesson unit or lesson sequence (learning) objectives

(2) Gather and interpret information about the students and the ways they intereact with the learning materials, resource persons, fellow students, the teacher

(3) Interpret and evaluate the data gathered through observation, testing, discussion, etc., and match with the learning objectives for the energy/environment lesson unit or lesson sequence

e. <u>Revise teaching strategies and/or learning objectives</u>

(1) Use the information gained above to:

- modify training strategies and tactics, and/or
- modify learning objectives

(2) Prescribe succeeding steps: If students' behavior indicates that desired learning objectives (knowledge, skills, attitudes) have been achieved, the teacher can proceed on to the next higher (complexity) level of objectives to be attained. If students' behavior indicates that desired learning objectives have not been achieved, the teacher may decide to:

- gather more data about the student
- modify the teaching strategies
- go on to the next lesson unit or sequence
- modify or change the content of the energy/environment lesson unit or lesson sequence
- modify or change the learning objectives

(3) <u>Reteach</u>: Reteach lesson units or sequences—which show unachieved learning objectives using modified teaching strategies of different techniques, different materials, different energy/environment subject-matter or processes. If the reteach modifications are successful, incorporate into a revised teaching plan. If not successful, modify objectives (substitute attainable ones for unattainable ones) keeping in mind individual student sophistication and ability.

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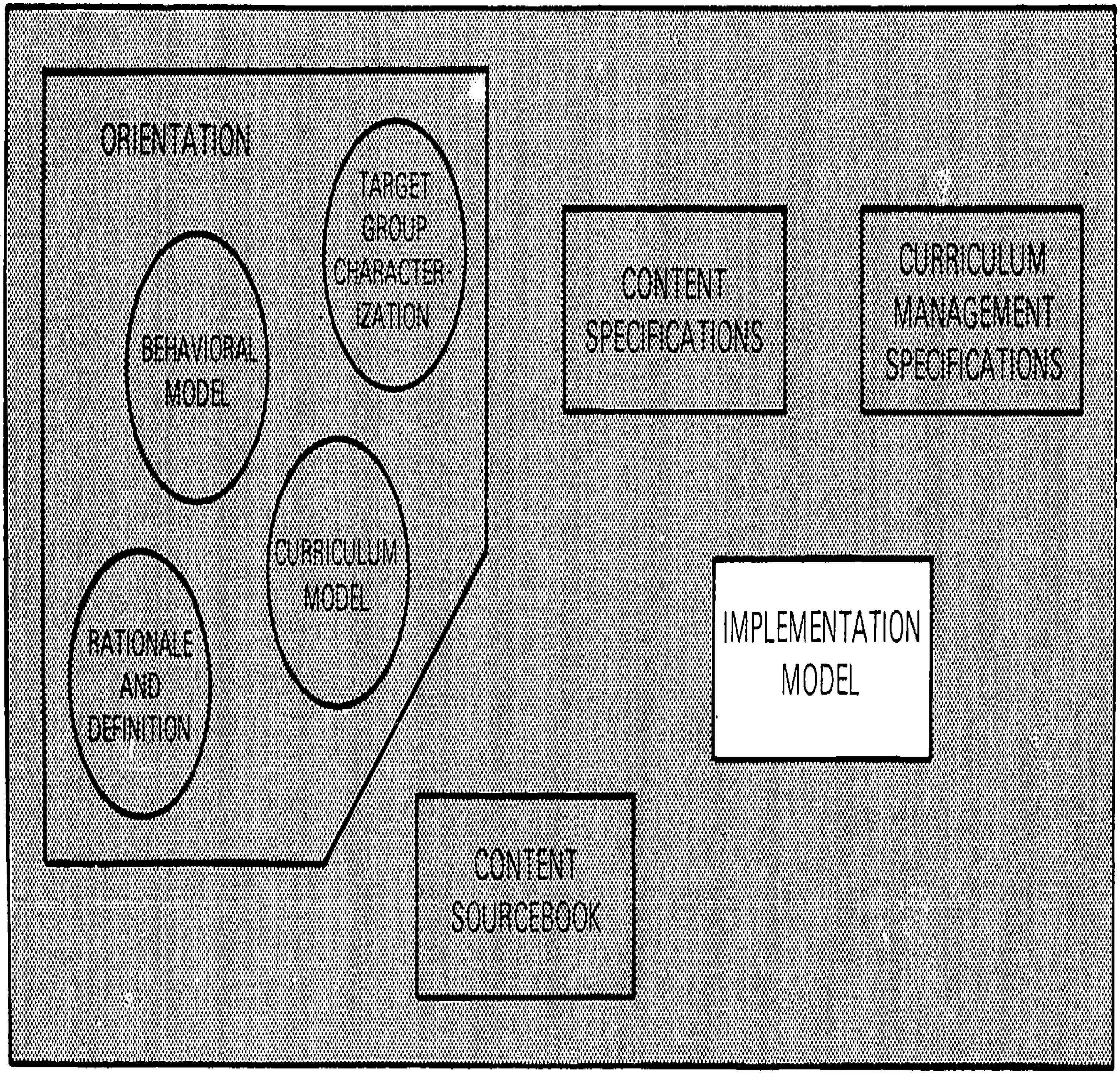
Implementation Model

THE HIGH SCHOOL ENERGY/ ENVIRONMENTAL EDUCATION TEACHER TRAINING MODEL



ENERGY/ENVIRONMENTAL EDUCATION
TEACHER TRAINING MODEL

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INTRODUCTION

The Implementation component of the Energy/Environmental Education Teacher Training Model describes the Implementation Model and the functions and interactions of its parts. It presents a systemic overview of the implementation process.

Part One describes the conceptual bases and components of the Implementation Model.

Part Two provides a structure/process view of the implementation process and describes characteristic activities associated with the components.

TABLE OF CONTENTS

PART ONE

THE IMPLEMENTATION MODEL

Part One will present the conceptual bases of the implementation model and describe the four components involved in the process.

A. CONCEPTUAL BASES

The set of conceptual bases from which the implementation model was derived are presented in two layers that constitute the conceptual input to the design of this model. These bases will be constantly in evidence as the components and component functions of the implementation model are described.

Two layers are delineated:

1. The Organizing Concepts constitute the first layer of the conceptual bases for the implementation model. They are derived from the holistic nature of the Energy/Environmental Teacher Training Model. The three most salient organizing concepts are:

   a. The program integrates two instructional/learning models: a goal-seeking approach and a process-oriented approach. Common to both are the expected knowledge, skill and attitudinal specifications outlined in the behavioral model of the EETTM. The goal-seeking approach begins with the definition of an energy/environmental learning task. It is controlled by feedback from an error signal (i.e., performance data) measuring the difference between expected and actual teacher outcomes, and it ends with teacher competence in specific knowledge and skills areas. The process-oriented approach, on the other hand, begins with the existence of a paradox, seeks to make visible to the teacher the contradictions existing within his/her own set of values and attitudes and ends with the teacher moving to a different level of self-awareness.

b. The training curriculum is anticipatory such that the instructional learning resources:

(1) are focused on the organization of information fields, rather than on the learning of specific information;

(2) erience oriented, not syllabus dominated;

(3) cate the development and internalization of higher levels of awareness rather than reliance on experts for guidance.

c. Instructional/learning arrangements are epitactically organized so that new knowledge and skills can be developmentally added to and integrated with knowledge and skills already possessed by the teacher.

2. The Curriculum Model, as displayed in Figure 1, represents the curriculum content specifications for the teacher training program and is derived from an analysis of the competences (outlined in the behavioral model) required by high school teachers to acquire and transmit energy awareness to students. As an outcome of this analysis, three competence domains have been defined:

a. mastery of holistic energy education content

b. competence in purposing, planning, implementing and evaluating instructional/learning arrangements

c. personal behavior and practices which demonstrate energy awareness and commitment to transmitting such awareness to high school students.

The following image of the curriculum model has emerged as these three competence domains were interfaced with the three organizing concepts outlined in the preceeding section.

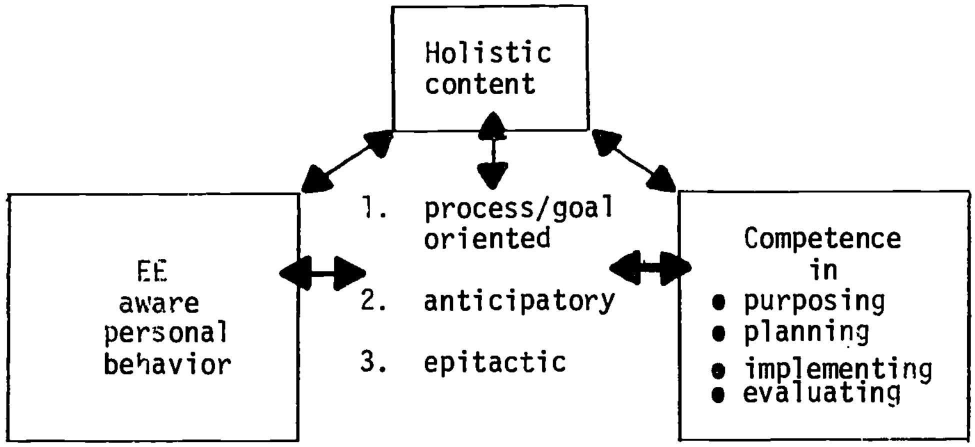


Figure 1. The Curriculum Model

The three boxes surrounding the organizing concepts represent the three curriculum domains. These domains present the content of the implementation model; the organizing concepts, on the other hand, determine the methods to be used to organize and present the content. The arrows indicate the intended interactive and integrative nature of the actual training curriculum.*

* For a linear presentation of specifications particular to each knowledge, skill and attitudinal domain, see the curriculum model as presented in the Orientation Manual.

B. DEFINITION OF THE COMPONENTS OF THE IMPLEMENTATION MODEL

A structural description of the components of the Implementation Model is presented below. The manner in which the components are related to each other is described in Part Two.

These components represent the instructional and institutional arrangements necessary to operationalize an energy/environmental education teacher training program.

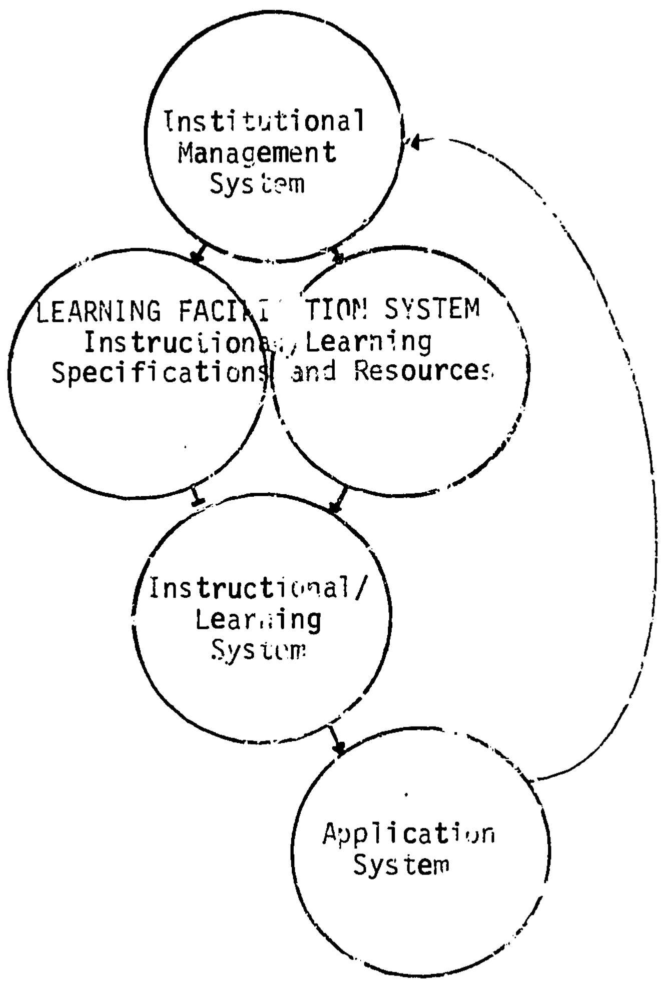
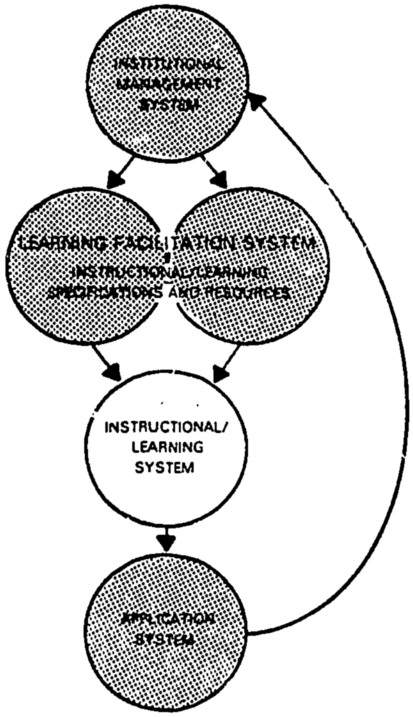


Figure 2. The Implementation Model



1. Instructional Learning Syst
(ILS)

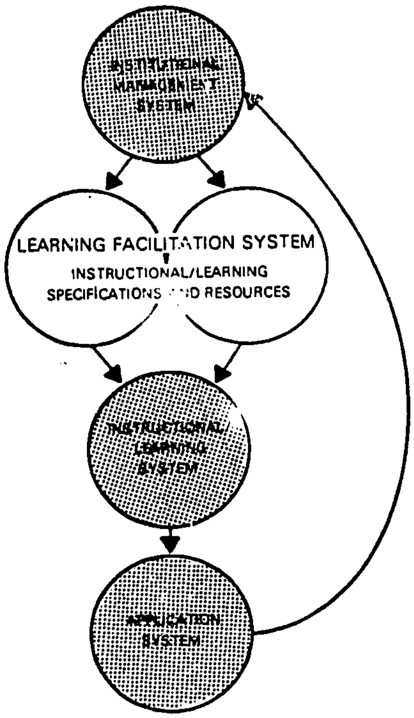
This system is the nucleus of the implementation model and is built around and in response to the needs of the teacher who becomes the learner (teacher-as-learner).

The instructional/learning activities of this system aim at the integration, rather than the re-education of the teacher.

The ILS uses information and resources from the Learning Facilitation System to purpose, plan, implement and evaluate a training curriculum.

The training curriculum will meet the following criteria:

- provides integrative, experientially based learning experiences
- utilizes holistic, interdisciplinary instructional/ learning method gies, materials and assessment strategies
- provides for differences in modes of inquiry and learning
- helps internalize the development of different levels of awareness
- focuses on learning "how to learn" rather than on "what to learn"



2. Learning Facilitation System (LFS)

The function of this system is to specify:

- the knowledge, skill and attitude competences
- instructional/learning strategies and methodologies

These strategies and methodologies will assist the trainer and the teacher in planning, implementing and evaluating an effective energy/environmental education teacher training program.

The two subcomponents of this system are:

a. Instructional/Learning Specifications which define the knowledge, skill and attitude competences to be addressed in the training curricula. These specifications are derived from the curriculum model (Figure 1). Specifically, they contain:

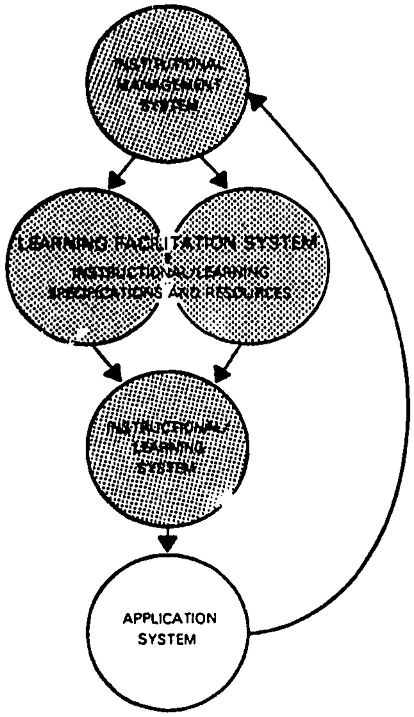
   (1) an inventory of knowledge, skill and attitudinal competences required by the high school teacher in the areas of: holistic energy education content, curriculum management, and personal behavior/awareness

   (2) overall rationale of program as outlined in the Orientation Manual

   (3) conceptual tools and heuristics of the energy content as presented in the Content Sourcebook

   (4) content and curriculum management specifications as presented in the Content Manual and the Curriculum Management Manual

b. Instructional/Learning Resources which identifies potential instructional/learning resources to assist in planning, implementing and evaluating an effective energy education teacher training program. These planning, implementing and evaluating resources will be identified in a Trainer's Resource Guide. (This Guide will be developed at a later date.)



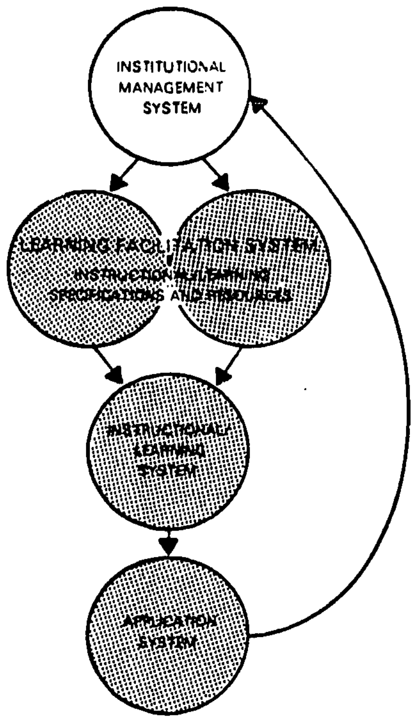
3. Application System (AS)

The function of this system is to provide for the development and designation of the instructional/learning arrangements where the teacher has the opportunity to integrate and apply the knowledge, skills and attitudes he/she has acquired.

The application of what is learned during the training program is not left to chance, but is provided by design through engineered on-the-job experiences.

Real or simulated application situations such as those listed below may constitute the activities of the Application System:

Real	Simulated
Actual classroom	Micro-teaching
	Critical incident
	Role playing



4. Institutional Management System (IMS)

This system is concerned with the overall institutional management and administration of the implementation process.

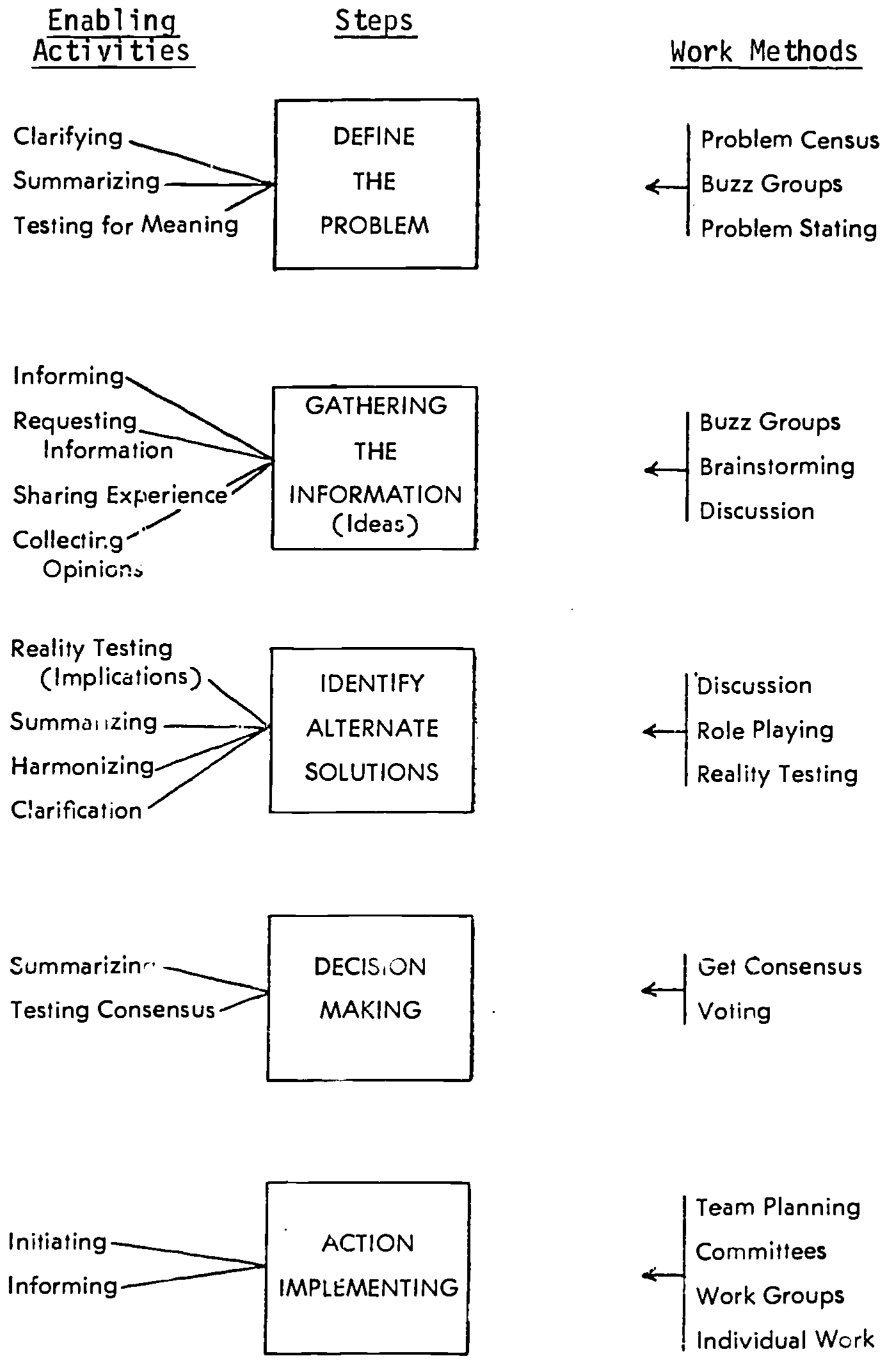
It is comprised of a management team of administrative, training and teaching personnel.

The management team will:

- develop and allocate resources for the Learning Facilitation System
- establish overall policies and funding priorities for implementation
- monitor and evaluate program effectiveness and efficiency.

A group decision-making model which may be helpful to the management team in effectively administering the implementation process contains the following steps and enabling objectives.*

*Adapted from steps in a decision-making model developed by Malcolm S. Knowles in The Modern Practice of Adult Education, New York: Association Press, 1970.



The management team also may choose to examine and adapt the holistic complex decision-making model outlined in the Orientation Manual and discussed in detail in the <u>Content Sourcebook</u>.

PART TWO

IMPLEMENTATION: A STRUCTURE/PROCESS VIEW

A structure/process view of the implementation model goes beyond the static structural definition of the components or parts as described in the previous section and presents an image of how the model functions as a whole through the interaction of its parts and processes. It is crucial to consider both the structure and the process dimensions in order to understand the ongoing, dynamic potential of the implementation model.

Four processes common to each of the components of the implementation model have been identified:

- purposing
- planning
- implementing
- evaluating

Within each of the components there appears, therefore, an interactive and integrative process of purposing, planning, implementing and evaluating with one of these processes being dominant in each component during implementation. For example, the dominant function of the Institutional Management System may be equated with the purposing process, while the function of the Learning Facilitation System may be seen as being involved primarily with the overall planning process. The following diagram portrays an image of the operationalization of the components within the purposing, planning, implementating and evaluating process framework.

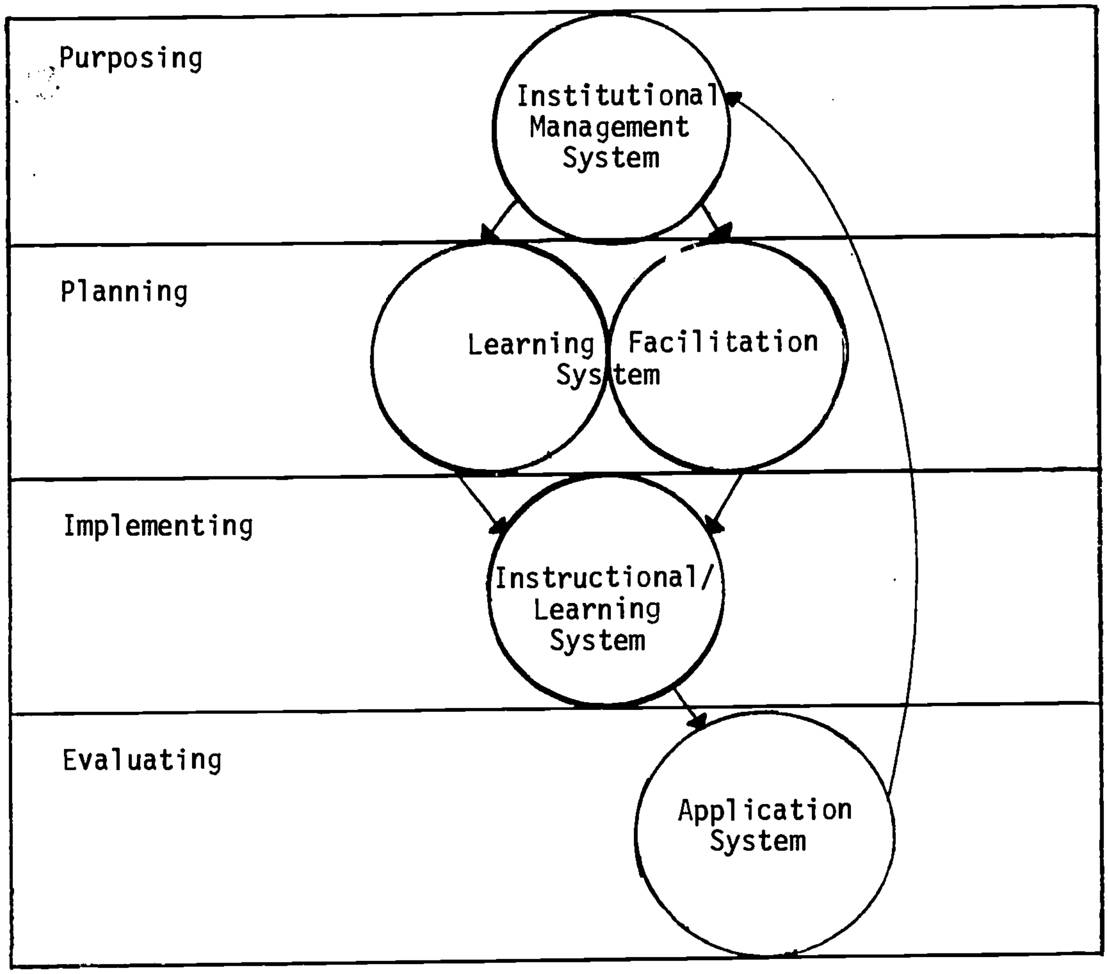


Figure 3. Implementation: A Structure/Process View

The arrows between the Institutional Management, Learning Facilitation and Instructional Learning Systems represent interactions which will be described in the following sections.

The arrow connecting the Application System to the Institutional Management System represents the evaluation of the implementation process. The information which flows between these two systems is used to make substantive changes and adjustments throughout the Implementation System.

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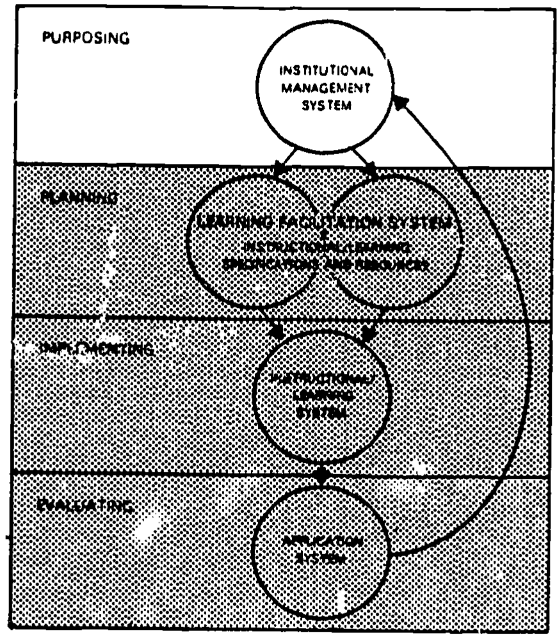


A. PURPOSING

During the purposing phase of the implementation process, the Institutional Management System will be operationalized through the establishment of a Management Team which includes:

- administrative personnel from a particular user group which has decided to implement an energy education teacher training program. Among the potential user groups would be school districts, university environmental institutes, or related state and federal agencies
- prospective high school teachers of an energy education course
- curriculum content specialists (science or social science)
- a trainer who will probably be a high level energy content and training person from such agencies as the state department of environmental education, the federal energy research and development area, or interdisciplinary environmental education institutes within a formal (university) or non-formal educational settings.

The Management Team should be comprised of a small group of people (for example 6-8) so that all participants have a chance to be involved in managing the different phases of the implementation process. It is of particular importance that some prospective teachers are included in this team as every individual tends to feel committed to an innovation to the extent he/she has participated and been involved in its inception and planning.

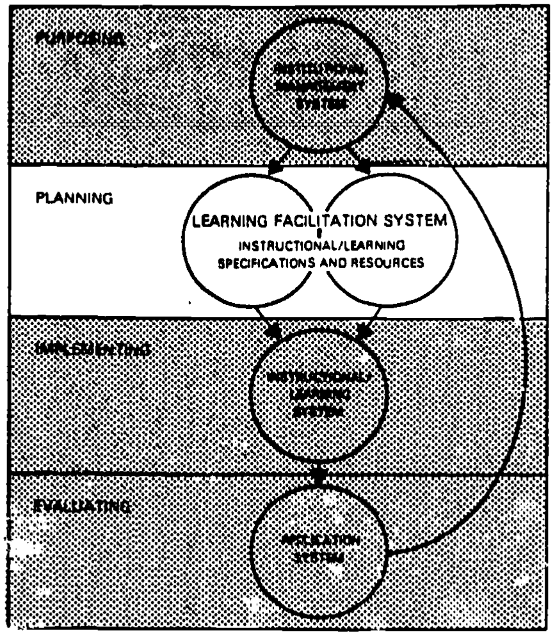
The initial purposing phase will involve the Management Team in orientation and assessment activities to ascertain the nature of the training needs of the prospective teachers and the consequent overall implementation goals and scope of the training program.

The Management Team will survey the EETTM requirements as outlined in the Orientation Manual and other documents contained within the Learning Facilitation System and then address the following types of questions:

- What personnel changes will be needed to introduce an interdisciplinary energy education course?
- To what degree will the innovation be compatible with current capabilities of prospective teachers of the high school energy education course?
- What additional instructional/learning resources and facilities will be needed to operationalize the training program?
- What additional knowledge, skill and attitudinal competences will the teachers need in order to meet the specifications outlined in the EETTM?
- What will be the estimated initial and long-term cost per teacher, and what will be the source for the anticipated budget increase?
- What incentives for involvement in the training program can be offered to the teachers?
- What is the administrator's and prospective teacher's commitment and attitude to the introduction of an energy education course?

Based on such an assessment, the Management Team will be able to:

- define the overall implementation goals of an energy education teacher training program
- identify additional training personnel
- specify whether training should take place at the pre-service, inservice, or graduate level
- make recommendations regarding financial commitment



B. PLANNING

During the Planning Phase, the Management Team will be involved in translating the identified implementation goals into a program format which is responsive to the need configuration of the user group (the teachers) and the host organization. Considering these goals and utilizing resources identified in the LFS, the Management Team will consider the following possible program configurations.

1. Individual/Group Formats*

   a. Formats for Individual Learning

      (1) apprenticeship and internship which refers to working closely in a supervised, practical experience with a competent "master" teacher already involved in energy education.

      (2) programmed instruction whereas the environmental education material would be presented to a teacher in a series of carefully planned sequential steps.

* This classification of program formats has been adapted from Malcolm Knowles, The Modern Practice of Adult Education, New York: Association Press, 1970.

b. Format for Group Learning

(1) Clinics, Institutes, and Workshops. All three refer to short, intensive, multiactivity, learning experiences. The clinic emphasizes the diagnosis, analysis and solving of problems arising out of the teacher's classroom experience while the institute emphasizes the development of knowledge and skills in a specialized area of concern. The difference seems to be in the problem/solution orientation of the clinic versus the more generalized knowledge and skill-seeking approach of the institute. The workshop, on the other hand, emphasizes the acquisition of individual competences largely through a variety of small group activities.

(2) Work Conferences which can be designed to serve fundamental educational purposes such as: presentation of experience and information, inspiration, training, and commitment to action.*

(3) Courses which are the traditional and primary group format for formal educational settings.

2. Institutional Setting

a. School site

b. University teacher education department

c. Community college

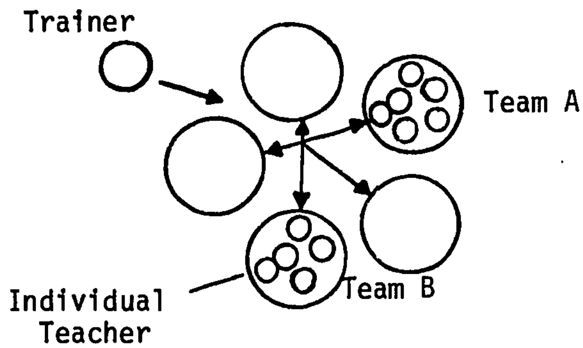
d. EE resource center

e. Education research and development center

3. Instructional/Learning Configuration which defines the relationships of the participants involved

a. Learning Team Approach. Teachers work together in small teams (4-6 members) to learn particular competence configurations identified in the training curriculum and then present these elements to the other groups involved in the program. This configuration may be displayed as:

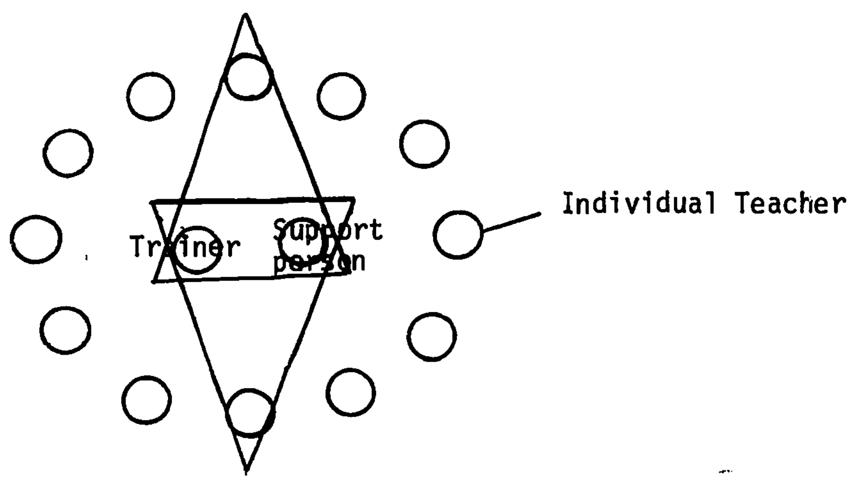
* For an expanded discussion of the basic principles underlying the work conference format and the steps involved in carrying these principles into practice, see Leland P. Bradford, "Planning the Work-Group Conference," Adult Education Bulletin, Vol. XII, February, 1948, pp. 68-69.



Learning Team Approach

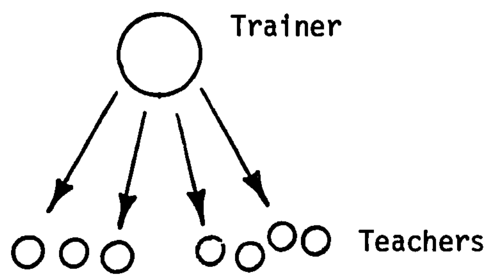
The role of the trainer in this situation is one of facilitating the learning teams of teachers in mastering the curriculum content (knowledge, skills and attitudes for transmitting the energy education content to students), facilitating the instructional/learning interactions of the teams, and evaluating the effectiveness of the process. This approach also could be implemented without a trainer by identifying a leader or coordinator from within each of the learning teams.

b. Learning Triad Approach. Each teacher is considered the key focus of his/her own instructional system. The trainer assists each teacher to purpose, plan, implement and evaluate a training curriculum responsive to their individual needs and interests. A third individual, a support person or advisor, is identified to participate in the training in order to provide support and feedback to the teacher after the training is completed and the teacher is actually implementing an environmental education curriculum in a high school classroom. This support person may be a principal or vice principal, curriculum specialist or a supervisor. As the diagram below indicates, each teacher is considered the focus of his/her own instructionl system while the trainer and support person are common to all systems.



Learning Triad Approach

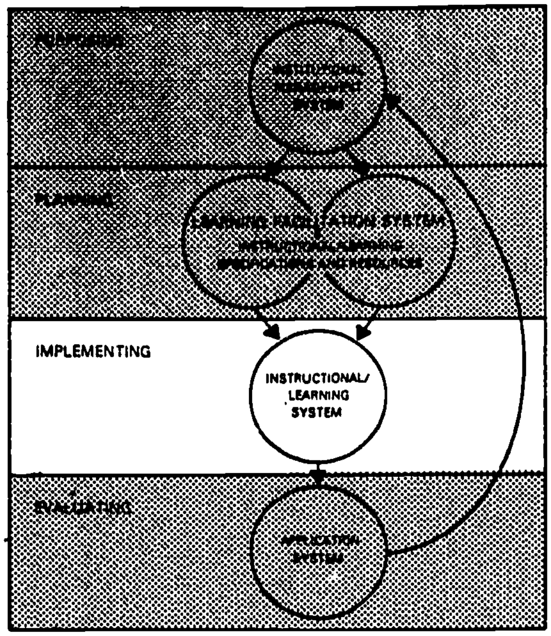
c. Subject Matter Top-down Instructional Approach. The trainer meets in a formal setting with a group of teachers at specified times for a predetermined length of time for presentation of a syllabus-oriented training program.



Top-down Approach

d. Self-instructional Programs. Individual teachers proceed at their own rate through self-instructional modules which incorporate objectives, pre-assessment, learning activities, and post-assessment measures. Some "expert" coordination and supervision is required.

After combining the above elements to create a responsive training program format, the Management Team will determine what additional resources (materials, media, personnel) will be needed in the Learning Facilitation System to implement the program which has just been planned.



C. IMPLEMENTING

The next phase of the implementation process involves the implementation of a training program within the Instructional/Learning System based on the purposing, planning, implementing and evaluation process.

If the members of the Management Team, for example, choose to implement an inservice workshop with a learning triad at their local school site, an energy education training program would involve the following characteristic activities:

1. Purposing

The goal of this initial phase within the Instructional/Learning System is to diagnose the educational needs of the teacher and establish the goals and objectives for the training program.

a. The trainer, teacher and support person triad will review the knowledge, skill and attitude specifications of the curriculum model presented in the Learning Facilitation System.

b. The trainer will provide the opportunity for the teacher to engage in self-diagnostic activities in order to enable the teacher to assess his/her current level of competence and communicate his or her goals for training and professional development, and personal interests. As the diagram below illustrates, the difference between the required level of competence and the teacher's current level will help establish the educational needs of the teacher.

required level
current level
} educational needs

c. The trainer and support person triad will help the teacher prioritize his/her education needs into professional knowledge, skill and attitude learning objectives. These objectives will then constitute the teacher's personal competence inventory for the EETT program.

2. <u>Planning</u>

This step within the Instructional/Learning System will:

a. review instructional/learning resources comprising the Learning Facilitation System.

b. consider and specify ways in which the teacher's performance and progress can be assessed in application situations (within the Application System)

c. select, develop and sequence instructional/learning arrangements

d. develop additional learning resources which will be needed

   (1) community facilities--museums, utility companies

   (2) local "experts," practitioners

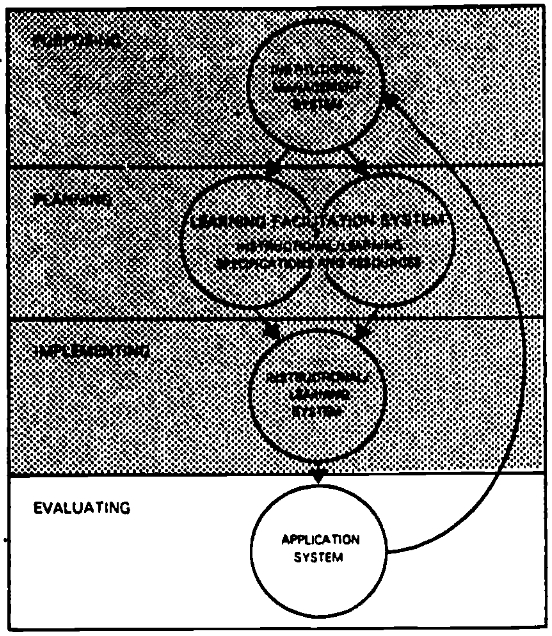
   (3) media, published materials.

3. <u>Implementing</u>

During this phase within the Instructional/Learning System, the teacher is engaged in the specified training experiences.

4. <u>Evaluating</u>

The teacher applies what he/she has learned in both real and simulated application situations. With the assistance of the trainer and support person, the teacher's performance within the Application System is monitored and evaluated in terms of the specified learning objectives and the required level of competences.



D. EVALUATING

The teacher, with the assistance of the trainer and support person, evaluates his/her performance in attaining planned competences acquired by the teacher. The Management Team uses this information to assess the effectiveness of the <u>entire</u> implementation process.

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