The Educational Side of Environmental Education;

With special consideration of Systems Thinking and Constructivist approaches of learning

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PREFACE

This thesis finalizes my study at the Agricultural University of the Netherlands. During the years I spent in Wageningen my interests increasingly focused on Environmental Education (EE) ranging from EE policy-making in Dutch municipals to EE in secondary schools.

I obtained inspiration for this thesis, not only from my strong belief in the need for EE, but also from Dr. Kerst Boersma who made me aware of the importance of looking at the educational side of EE. He also came up with the idea to study constructivist approaches of learning and systems approaches, in order to find out how they possibly can contribute to both the development and implementation of EE in Dutch secondary schools.

These two approaches make up the core of this paper. The contributions they may offer to EE are described, as well as some of their philosophical implications. I hope the content of this study will lead to more debate about the role EE has to play in secondary education, but also about whether the current educational system allows it to play such a role!

Thanks are owed to my supervisors; Art Alblas (Department of Education Teacher Training) and Jan van der Made (Department of Nature Conservation), who gave me valuable feedback along the way. I would like to thank Art in particular for being my personal advisor for almost two years in a row. During those years it was wonderful working with him.

Thanks are also due to Kerst Boersma of the National Institute for Curriculum Development for the reason mentioned above, and for commenting on my proceedings.

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CHAPTER ONE: INTRODUCTION

Environmental Education (EE) in school-settings is receiving renewed and more profound attention. The Dutch Ministeries of Agriculture and Fisheries, of Housing, Physical Planning and the Environment, and of Education and Science, recently addressed an interdepartmental paper to the parliament in which they write that particularly in education it should be attempted to increase knowledge and insights in environmental problems (Deetman 1986).

Within the educational field several EE projects are being carried out under the guidance of institutes for EE, curriculum development units and universities (e.g. NME-VO (EE in Secondary Schools Project), ECEEN (European Community Environmental Education Network), SLO NO 12-16 (Conservation Education Project of the National Institute for Curriculum Development)).

The roots of the Dutch environmental education movement lie in the conservation movement rather than in the schools themselves (for a brief review of the development of Dutch EE see Wals, 1986). This partially contributes to the gap that exists between EE institutes on the one hand and the schools and curriculum development units on the other. The latter ones suggest that the EE programs developed by EE institutes are predominately based on good intentions rather than on educational and pedagogical theory and practice (e.g. Alma et al., 1983; Boersma, 1986; Schermer, 1986). This gap is further maintained by the interdisciplinary nature of EE (see chapter 2) which contrasts the disciplinary organized Dutch educational system. The nature of EE, as we will see in the next chapters, apparently demands a different approach to education.

It has been argued by Boersma that '... discussions about EE tend to concentrate more often on its desired content and less often on how it should be organized in order to reach the desired effect' (Boersma, 1986; 1).

This study is an attempt to look at the educational side of EE with special consideration of the philosophical foundations implied. It is needless to say that the educational side de-

pends on the content and the desired outcomes of EE as well. Therefore chapter two contains some reflections on the goals and the content of EE, after a comparison of some superordinate goals of EE as they have been stated by various (inter)national groups, active in the field of EE. The reflections derived from the brief "goal analysis" will result in a superordinate goal for EE, followed by intermediate goals (objectives) for EE in schools.

The nature of EE, its desired outcomes, and the need to bridge the gap between the "EE movement" and the reality of educational practice, bring me to two approaches that may further the development of EE. These two approaches are; a constructivist approach of learning as a tool for organizing the EE learning process and systems thinking as a tool for a.o. organizing the content of EE.

Both approaches seem promising for education in general but will be reviewed here in the light of EE. Constructivist approaches of learning are recently receiving (renewed) attention in research in secondary school science education (Pfundt and Duit, 1985), but, as far as I know, have up until now not been regarded in the field of EE.

Systems approaches have been previously applied in the field of EE, usually linked to ecology. They will be critically reviewed here for, as will be argued later on, although they offer great potential for enabling teaching and learning the earth as a "whole", they at the same time may result in a cybernetic view of nature (manipulation and control) possibly giving the approach a conservative bias.

The justification for taking these approaches at the core of the educational side of EE not only lies within the nature of EE but also in research that has been carried out in the past.

Chapter three will deal with constructivist approaches of learning and their implications for EE in secondary schools. Chapter four will deal with systems approaches and how they may be used for; organizing the world as the students perceive her, enhancing a "mode of thinking", and planning the educational system in which EE is to take place. In chapter five a synthe-

sis between the two approaches will be established. The synthesis will result in some reflections on a philosophy of EE and their implications for learning, teaching and curriculum development.

This thesis is the result of; a review of research that has been carried out in the past, feedback from my advisors, participating in a national conference on EE in school-settings (Frings, 1987) and of organizing my own thoughts. The study has both an eclectic and a bibliographic character, in that it selectively links two approaches to EE and provides an overview of most of the related literature.

The study has been carried out during a time in which the content of Dutch secondary education is facing changes (WRR, 1986) that should not be underestimated. If EE is to become an integral part of the Dutch school system in the near future, then we have to start looking at the educational side of EE and its philosophical foundations today rather than tomorrow.

CHAPTER TWO: GOALS OF ENVIRONMENTAL EDUCATION

2.1 The Importance of a Clear Statement of Goals

In this chapter I will confront several superordinate goals which have been formulated by various (inter)national groups active in the field of environmental education. This is in order to reveal some differences that may at first look very small, but may have great impact on the resulting EE activities.

In the Netherlands various organizations stress the importance of EE as a tool for maintaining and improving the balance between the quality of life and the quality of the environment. However, they often have different views on how to maintain and improve this balance. These differences often origin from the "worldviews" the members of the organizations have. These views may include; the way society is perceived (e.g. static versus dynamic), the evaluation of ones own role in society (e.g. passive versus active), the evaluation of the causes of environmental problems (technological nature versus societal nature), and so on. These different views may result in different approaches to EE.

For instance, one organization may view environmental problems basically as technological problems which can be solved by "clean technology" and legislation. EE then may be seen as a way to help the citizen understand the use of environmental laws and the reasons for paying environmental taxes. This might be called a technical-pragmatic view.

A second organization may view that the cause of environmental problems lies within the structure of our society. EE then may be viewed as a means to (fundamentally) change the structure of society by making citizens take a critical stance towards themselves and the world they live in. This view may be called a critical view on the structure of society.

A third organization may see environmental problems as a cultural problem. It then may be argued that technological development made it possible to adopt a "new life-style". This

new life-style is a materialistic one which disturbes the balance we used to (..) keep with the natural environment. Solutions may be sought in a so called "back to nature" movement. EE may then be regarded as a tool to restore the love and appreciation we used to (..) have for our natural environment. This view may be called a critical view on culture (for a more detailed description of these views, see: Van Woerkum, 1985).

The positions described above are obviously extreme ones, however, they can be traced back to various Dutch EE programs (e.g. Baayens, 1983; Wals, 1986).

Since this study is concerned with EE in the formal educational system, it is important to obtain at least some consensus on the content and the desired outcomes of EE.

Hobart, in reviewing the (lack of) development of conservation education in the U.S. states: 'If lacking a coordinated, comprehensive, and uniform base, environmental education too will grind to halt, axle deep in the same stuff that buried conservation education, for the failures of conservation education were rooted in the lack of its foundation' (Hobart, W.L. cited in: Hungerford et al., 1980; 42). Van de Visse and Stapp (1975) warned that without a clear statement of goals an EE program would become a series of unrelated experiences, focusing on limited program objectives.

Fortunately some attempts have been made to achieve some consensus at the international level on both the superordinate and the intermediate goals (objectives). See for instance; UNESCO/UNEP, 1977 and ECEEN, 1982). At the national level similar attempts have been made in for instance; CNBE, 1985; Deetman, 1986 and Frings, 1987. Nevertheless the warnings given above, in my opinion, are still of concern for the development of EE in the Netherlands.

In order to study the educational side of EE, which is the major concern of this paper, it is important to start with defining the content and the desired outcomes of EE. Stating a superordinate goal alone is not enough, for such goals have a tendency to remain up in the air. Therefore it is crucial to state intermediate goals as well. These intermediate goals eventually will have to result in instructional objectives that

can easily be put into effect in- and outside the classroom.

This chapter is concerned with the superordinate and intermediate goals of EE only. It is not until these have been clearly defined when one is able to pay attention to the educational side of EE.

Looking at the educational side, with its own requirements for successful EE, will result in a change of perspective and thus lead to a re-adjustment of the goals stated in this chapter. This re-adjustment will have philosophical implications as well. They will be presented in chapter five, the final chapter of this paper.

2.2 An Analysis of Superordinate Goals of Environmental Education

In paragraph 2.1 it has been argued that seemingly small differences in superordinate goals may hide significantly different worldviews and may therefore result in varying EE programs. The need for achieving at least some consensus on the superordinate goal of EE in the Dutch educational system has been stressed. In this thesis a superordinate goal is considered to be a "statement of the art", describing the desired outcomes of EE in general and abstract terms. Its purpose lies in serving as a point of reference and/or orientation.

In this paragraph I will present twelve superordinate goals that have been formulated by various national and international organizations active in the field of EE. Some of them focus on EE in general whereas others focus on EE in schools in particular. They generally have in common that they reflect on the content and the desired outcomes of EE rather than on a specific methodology.

-1- EE is the process of becoming aware of the natural environment, an environment which is influenced by man. This process, which stems from learning through discovery, should focus on stimulating a behavior pattern that takes

the environment as a whole into account, and on developing skills that promote participation in decision making and opinion-forming processes in the sphere of the environment (Stichting Veldstudie Centra, 1985; translation, AW).

-2- The goal of EE is to improve pupils' ecological awareness and hence their environmental behavior, and also to put them in a position to adopt attitudes or hold opinions on social developments (Papendorp, Landelijk Steunpunt Natuur- en Milieu-educatie, 1985; translation, AW).

-3- EE should provide people with the opportunity to acquire knowledge about, and to gain insight in;

- nature as the origin and prerequisite of life,
- the way human activities influence the quality of nature and the (human) landscape.

By doing so EE; creates a sense of responsibilty leading to both thoughtful personal choices and to choices one makes as a citizen, respecting the balance between man and nature; and contributes to the development of the attitudes and skills that enhance putting these choices into effect when shaping society (Commissie voor Natuurbeschermingseducatie, 1985; translation, AW).

-4- The goal of EE is to help people raise conciousness about and commitment to the problems that occur in conserving and managing a healthy environment for man, plants and animals. Effective education will develop knowledge and skills one needs, both as an individual and as a citizen, to contribute to; responsible management of the environment, solving the existing environmental problems and avoiding new ones (Deetman, 1986; translation, AW).

-5- EE should enable people to recognize the factors that determine nature and quality of the human environment so that all respect and appreciate it to the full and parti-

cipate constructively, as individuals and as citizens, in its management and development (F.Crawford member of the Scottish Strathclyde EE Group in: Gravenberch, 1985).

-6- EE is a process aimed at the production of a citizenry that is;

- knowledgable about the biophysical and sociocultural environment of which man is a part,
- aware of environmental problems and management alternatives of use, in solving these problems,
- motivated to act responsibly in developing diverse environments that are optimal for living a quality life,
- willing to be involved in social activities for improving the environment in which he lives (Israeli EE Project in: Gravenberch, 1985).

-7- EE, derived from Action Research, enables students to participate more fully in the learning process and to assume greater responsibility for learning, as they engage in a problem-solving process aimed at resolving a (local) environmental issue that they have identified. It should encourage the integration of basic disciplines and improve the (local) biophysical and social environment by actively linking classroom education with the real-world (free after Di Chiro and Stapp, 1985).

-8- EE should aid citizens in becoming environmentally knowledgable and, above all, skilled and dedicated citizens who are willing to work individually and collectively, toward achieving and/or maintaining a dynamic equilibrium between the quality of life and the quality of the environment (Gary D. Harvey cited in Hungerford et al., 1980).

-9- EE should adopt a critical approach to encourage careful analysis and awareness of the various factors involved in the (environmental) situation...All decisions regarding

the development of society and the improvement of the lot of individuals are based on consideration, often implicit, concerning what is useful, good, beautiful and so on. The educated individual should be in the position to ask such questions as: Who took this decision? According to what criteria? With what immediate ends in mind? Have long term consequences been calculated? In short, he must know what choices have been made and what value system determined them (Unesco, 1980).

-10- EE should enable children;

- to master the notion of a system (e.g. eco-system) and to discover its laws of equilibrium and the relationships established within it,
- to realize that man has an active and constructive role to play in his environment by teaching them to be responsible and to know how to make decisions (European Community Environmental Education Network, 1982).

-11- EE is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness of man, his culture and his biophysical surroundings...EE also entails practice in decision-making and self-formulation of a code of behaviour about issues concerning environmental quality (IUCN, 1970).

-12- EE...should constitute a comprehensive lifelong education, one responsive to changes in a rapidly changing world. It should prepare the individual for life through an understanding of the major problems of the contemporary world, and the provision of skills and attributes needed to play a productive role towards improving and protecting the environment with due regard given to ethical values. By adopting a holistic approach, rooted in a broad interdisciplinary base, it recreates an overall perspective which acknowledges the fact that natural environment and man-made environment are profoundly interdependent. It

helps reveal the enduring continuity which links the acts of today to the consequences for tomorrow. It demonstrates the interdependencies among national communities and the need for solidarity among all mankind. EE must look outward to the community. It should involve the individual in an active problem-solving process within the context of specific realities, and it should encourage initiative, a sense of responsibility and commitment to build a better tomorrow. By its very nature EE can make a powerful contribution to the renovation of the educational process (UNESCO, 1977).

All the goals are compared in the matrix which is presented in table 2.1.

Table 2.1 A comparison between superordinate goals of EE

	1	2	3	4	5	6	7	8	9	10	11	12
core of content:												
natural env.	x	-	x	x	x	x	-	-	-	x	x	-
human env.	-	-	-	x	x	x	-	-	-	-	x	-
total env.	£	x	-	-	-	-	x	x	x	-	-	x
desired outcomes:												
awareness	x	x	-	x	£	x	£	-	x	-	-	£
sense of resp.	-	-	x	x	-	x	£	x	-	x	-	x
knowledge	£	£	x	x	x	x	-	x	x	x	x	x
resp for learn.	-	-	-	-	-	-	x	-	-	-	-	-
holistic think.	£	x	x	-	£	-	£	x	x	x	x	x
opinion forming	x	x	£	-	-	-	£	-	£	-	-	£
critic. society	-	x	-	-	-	-	£	-	x	-	-	-
critic. oneself	-	£	-	-	-	-	£	-	£	-	-	-
evaluation of ones own ..:												
learning	-	-	-	-	-	-	x	-	-	-	-	-
values	-	x	x	-	£	-	£	-	x	-	x	x
behaviour	x	x	£	£	£	£	£	£	-	£	x	£
skills:												
problem-solving	£	£	£	x	£	£	x	£	£	£	-	x
decision-making	x	£	x	£	£	£	£	£	x	x	x	£
taking action	-	£	£	£	x	x	x	£	-	£	£	x
participation	x	£	-	-	x	£	x	£	-	£	-	£
improvement of learning env.	-	-	-	-	-	-	x	-	-	-	-	x

x means: content and/or desired outcome explicitly mentioned in the superordinate goal (either by using the same concept or by using one with a similar meaning).

£ means: content and/or desired outcome implicitly mentioned in the superordinate goal or known to be an implicit part of the superordinate goal from the source indicated.

- means: neither explicitly nor implicitly mentioned in the superordinate goal. This does not always mean that they are considered to be unimportant or irrelevant.

The selection of the goals is based on immediate availability rather than on a thorough search. One criterion, however, was that a goal should at least have had wide (inter)national attention and/or have resulted in curricula for EE.

What can be learned from the matrix presented in the table? Before answering this question two restrictions of the matrix have to be put forward. First of all it should be noted that the list of desired outcomes may not be complete and only serves to provide an overview of the most common ones. Secondly it should be noted that both the choice of goal statements and the choice of an x, £ or -, are to an extent arbitrary and thus debatable.

Looking at the matrix one can notice some important differences. First let us look at the core of content. Some groups (1, 3, 10) take the natural environment at the core of content, possibly taking a critical view on culture (see 2.1). Some (4, 5, 6, 11) take both the human and the natural environment at the core of content of EE. Others (2, 7, 8, 9, 12) take the environment as a whole at the core of content, possibly suggesting that the human and natural environment are profoundly interdependent and cannot be seen seperately.

Without suggesting that one approach is better than the other -I will later on- it is obvious that the specific subject matter of EE needs to be clearly defined and the underlying choices should be made explicit.

Looking at the desired outcomes one faces differences that in my opinion often can be brought back to the question: Can or may teachers influence students' values, attitudes and behaviors toward an environmentally sound direction? The answer to this questions a.o. determines whether emphasis is placed on knowledge and insights, on attitudes and values or on behavior and (action) skills.

Decisions on content and desired outcomes are of great importance, however, when discussing the implementation and development of EE within the formal Dutch educational system, something else should be considered first. Namely: Is EE different from traditional (science) education? This question is crucial for there is a growing support, among those active in

the field of EE in secondary schools, for developing and implementing EE by building upon the existing disciplines (e.g. Frings, 1987). The disciplines of biology, physics, chemistry, economics and geography are being mentioned as being potent for this purpose.

Both questions raised will return in the next two paragraphs.

If EE is to be developed within these disciplines then a prerequisite must be that traditional science education is an appropriate vehicle for making this development possible. It will be argued in the next paragraph that this is not the case. Traditional science education needs to change first before it can serve as a strong enough base for the development and implementation of EE in secondary schools. Therefore, before discussing the differences revealed by the matrix presented in table 2.1 and before moving on towards superordinate and intermediate goals of EE, an alternative view of science education will be presented.

2.3. Criticisms of Traditional Science Education

In the last paragraph I mentioned the growing support for developing and implementing EE within the existing scientific disciplines. I suggested that traditional science education in itself is an inappropriate starting point for this purpose. Here it will be argued why.

Traditional science education is predominately concerned with transfering knowledge and insights which are relevant to a certain discipline (e.g. physics, chemistry and biology). Its roots lie in positivist science tradition which tries to understand/explain this complex world by reducing it into some testable proportions, experimentally testing the resultant hypothesis through some sort of quantification, by reduction of as many variables as possible and deducing an ultimate outcome in the form of a "this is why statement" (Bawden, 1984).

The real world thus has been divided into disciplines with their own laws ("truths") and their own core of content. The

described empiristic method of science builds up a continuously refined account of the universe and has lead to a technology which, without any doubt, has improved life on earth for many (not equally for all though...). The methodology of science and consequently that of science education is deeply embedded in Western civilization. We even speak of "science illiteracy" as a threat to our future (personal) development.

We have to occasionally remind ourselves, however, that despite of its contribution to "progress", traditional science has its limitations and its myths. It is limited in the sense that its reductionist approach has a build in tendency to create new realities rather than to explain the "real world". It is what has been called the disadvantage of knowing more and more about less and less (e.g. Von Bertalanffy, 1968). Neither does the methodology seem to be satisfactory when applied to real world problems (as opposed to the scientist-defined problems in the laboratory) or when applied to social phenomena (Checkland, 1981).

Applied science (technology), by some, is considered to be the solution to all problems (including environmental ones...), but has caused many problems as well. Or, as Von Bertalanffy puts it: 'The mechanistic worldview, taking the play of physical particals as ultimate realitity, found its expression in a civilization which glorifies physical technology that has eventually lead to the catastrophes of our time'(Von Bertalanffy, 1968; 49). Besides these restrictions there seems to be a dangerous myth of science as being a power and value free enterprise (Habermas, 1971).

What does the nature of traditional science imply for disciplinary based science education in secondary schools? For one it has a tendency to create a gap between the content of real life experiences and the content of the science curricula. Besides that it may also create a gap between the different disciplines, for it is suggested that they are seperate fields of inquiry.

Von Bertalanffy cites Mather who suggests that: 'One of the criticisms of general education is based upon the fact that it may easily degenerate into the mere presentation of information

picked up in as many fields of inquiry as there is time to survey during a semester or a year...If you were to overhear several senior students talking, you might hear one of them say: "Our professors have stuffed us full but what does it all mean?" More important is the search for basic concepts and underlying principles that may be valid throughout the entire body of knowledge'. Mather concludes: 'Integrative studies would prove to be an essential part of the quest for an understanding of reality' (Mather cited in Von Bertalanffy, 1968; 50).

The world outside us is not "logically" divided into geography, biology, physics, chemistry and so on. Botkin et al.(1979) conclude that there is a dichotomy between schools and life which stems from the inability of schools to adapt to the reality of the world ouside their walls. Among other things they suggest to combine theoretical training with the practice of living.

McInnis (1971) adds to this discussion that thinking the world into pieces (analysis, reductionism, specialization, departmentalization) is important and essential for technological progress, but it is only half the understanding. He even states: 'No institution presently does more to shape/misshape our perceptions of the world than our schools' (McInnis, 1971; 2). He suggests that we need a complementary curriculum to teach the earth as a whole.

After studying students' reasoning in socio-scientific issues -issues involving the social, ethical, and political implications of scientific findings and their uses (Wessel, 1980; 4, 5)- Flemming concludes: 'students overwhelmingly agreed that scientists do have all the facts and that the facts are synonymous with "the truth" '(Flemming, 1985; 208). He further states: 'Scientific knowledge is currently presented in schools without an accompanying explanation of how the information became accepted as a fact. As a result students have an unrealistic picture of science, an idealized view' (Flemming, 1985; 208).

Flemming's study reveals that many students believe the major aim of science and technology is progress for the advan-

cement of civilization. While civilization is a creation of humanity, students see the advancement of civilization as a process in which individuals' concerns are increasingly ignored, according to Flemming. He therefore considers '...helping students to understand; who in our society is involved in assessing benefits and risks of research, who is dedicated to the search for truth and who is most concerned with social purpose' (Flemming, 1985; 210), to be part of the responsibility of the educator. Although his study was carried out in Canadian high schools, the results may be of importance to the innovation of the Dutch secondary school curriculum as well.

A generally accepted goal of public education is to encourage informed and rational citizen participation (e.g. WRR, 1986). Bybee (1985) -in answering the question: What should the scientifically and technologically literate person know, value, and do as a citizen?- notes that whether citizens are informed or ill-informed, their attitudes affect social policies as much as their knowledge and skills do. He then reformulates his question into: How can we encourage citizens' responsiveness to personal, environmental, and public policy issues involving science and technology? He suggests that students should;

'- learn basic science concepts and processes,
- understand the nature of science and technology,
- understand the limits and possibilities of science and technology as forces for social change'(Bybee, 1985; 84).

A different criticism of traditional science education comes from Lewin. He criticized traditional classroom practices by arguing that they only seek to induce students about <u>other</u> peoples inquiries, whereas students should be involved in processes of inquiry in areas where their <u>own</u> beliefs are recognized by them to be vague, conflicting, or somehow in doubt (Lewin in: Schlipp ed., 1949). Although written in 1949, this criticsm is still valid for most contemporary education.

Lewin proposes that students conduct their own experimental inquiry in which their own feelings, perceptions, commitments and behaviors are the data to be processed. 'Experiences which have not been prehypothesized need to be reflected upon and

conceptualized post factum, if valid learnings are to issue from the training process' (Bennis et al., 1976; 321).

A criticism of traditional science education, indirectly derived from Lewin, is that it ignores students' ideas, beliefs and perceptions. Too often the learner is still viewed as a passive consumer of knowledge. Instead he/she actively constructs his/her own interpretations of information, and draws inferences from them. 'The brain ignores some information and selectively attends to other information...much more than a "blank slate" that passively learns and records incoming information' (Osborne and Wittrock, 1983; 492).

It is suggested that students' own ideas, frameworks, alternative conceptions, and mini-theories, as they have been called by various researchers in science education (e.g. Driver, Oldham, Erickson, Bell, Osborne, Nussbaum, Novick, Hasweh) should be taken at the core of the curriculum, rather than the ideas of for instance Newton and Einstein. Gergen states: 'Scientific formula would...not be the result of an impersonal application of decontextualized, methodological rules, but the responsibility of persons in active communal interchange' (Gergen, 1985; 272).

From the above it can be concluded that traditional science education can be blamed for;

- thinking the world into pieces,
- creating a gap between the content of the curriculum and the content of real life experiences,
- paying insufficient attention to the way science and technology relate to societal problems,
- paying insufficient attention to the fact that science and technology are human achievements,
- ignoring the ideas, beliefs and perceptions students bring into class.

In my opinion these five points of criticism should be of importance for the whole curriculum, including EE, within the formal educational system. It is not until traditional science education changes in perspective, bearing in mind these five

points, when it may serve as an appropriate base for the development of EE in Dutch secondary education.

In the next paragraph I will return to the differences in content and desired outcomes of EE revealed by table 2.1 when trying to find an answer to the question: What makes education environmental?

2.4 What Makes Education Environmental?

Traditional science education has been criticized. It has been suggested that it needs to change before EE can be successfully implemented and developed within the various disciplines. I will argue that EE introduces some new dimensions to disciplinary based education. Dimensions that raise some dilemma's which will be presented as well.

Whereas for instance physics has as its field of inquiry the world of physics, EE has as its field of inquiry the world we, including other living creatures, live in. Whereas physics education aims for the understanding of the basic concepts of physics and hopefully also for a.o. understanding the role physics plays in shaping our society, EE clearly aims for improving/changing the world we life in. EE in my view has a change component.

EE is not only education <u>about</u> and/or <u>in</u> the environment, it is also education <u>for</u> the environment. The distinction between EE in, about, and for the environment has been previously made by Lucas (1979 and 1980a,b). EE for the environment a.o. aims for the improvement of the environment. The improvement and/or protection of the world we life in is a highly controversial problem which can not be solved by students alone. It would be pretentious to believe so.

We do seem to have a dilemma which has been put forward by Novak: 'Schools are a reflection of society. They are in general no better and no worse than the society that supports them... Do we improve society to improve schools or do we improve schools so that the graduates move out to improve society? Where do we break the circle?' (Novak, 1977; 30).

The questions raised by the dilemma make EE in principle different from (traditional) science education. Since EE is concerned with the improvement of the world we live in, it should always be an attempt to break this circle by improving both the schools and the (local) community. In my view this implicitly requires that classroom education and the students' real world are actively linked.

Since the improvement of the environment is a controversial issue, EE provides an excellent tool to clarify the values, beliefs, and attitudes students bring into class. We have to realize though that '...schools in free societies may never become the places where most values of students are acquired, but they should teach students to understand what values are, how they are acquired, and what the societal consequences of differing values may be'(Novak, 1977; 164).

In the light of EE we are particularly concerned with the consequences of certain values on the quality of the environment. Whether talking about values, beliefs or behavior patterns, some contribute more to the destruction/improvement of the environment than others, others even may lead to both at different times. May educators influence values, beliefs, attitudes and behavior patterns in an environmentally sound direction, regardless of whether or not this is possible?

There is worldwide consensus on that man's continued existence is seriously threatened by the way he has thus far treated the environment and the earth's natural resources (see e.g. IUCN, UNEP, WWF, 1980). Boersma (1986), in stressing the importance of the educational side of EE, states: 'Some people hold that any means of changing human behaviour is permissible if it averts this threat; but to adopt this approach would be to pen the door to every kind of indoctrination...teaching must not consist of mindless drills or covert attempts to influence thinking and behaviour'(Boersma, 1986; 3, 4).

He continues by asking if effective education is still possible then? 'There seems to be a paradox here. If you do not influence learners in the desired direction, you contribute to allowing our society to remain unchanged -with a possibility of total destruction- but if you do influence learners in the de-

sired direction, you contribute to bringing into existence an undesirable form of society which may itself possibly lead to a great deal of missery'(Boersma, 1986; 4).

Several researchers have opposed indoctrination (of the covert mindless drill kind) with values clarification (e.g. Simon et al., 1972; Caduto, 1984). What is the difference?
The values clarification approach does not aim to instill a particular set of values according to Simon et al.(1972). They suggest that the teacher uses approaches which help students become aware of the beliefs and behaviors they prize and would be willing to stand up for in and out of the classroom. The teacher, they suggest, should use materials and methods which encourage students to consider alternative modes of thinking and acting. By doing so students learn to weigh the pros and cons and the consequences of various alternatives. The teacher should help students consider whether their actions match their stated beliefs, and if not, how to bring the two into closer harmony. Finally the teacher should try to give students options in and out of class, for only when students begin to make their own choices and evaluate the actual consequences, do they develop their own views (Simon, et al., 1972).

It thus seems that the value clarification procedure focuses on the <u>process</u> of valuing and not on the transmission of the "right set of values". This does imply that a student may very well develop values that are not environmentally sound! Here the teacher's values come in, since his/her values are equal to those which the students bring into class and are of equal importance for value clarification. If students are not confronted with alternative (e.g. environmentally sound) perspectives, they are likely to assume that all "reasonable people" have similar commitments (Brown and Tandon, 1983).

The values an environmental educator brings into class are, from a pedagogical view, equal to those of the students and not any better or worse. They should/can not be kept secret but instead should be clarified and discussed as well. Only then can mindless drills and covert attempts to influence students' lifes be avoided.

From an environmental view, however, some values <u>are</u> better

than others. With the purpose of improving the environment in mind, it may be hard to maintain that in the classroom all values are equal and should be equally respected. This is, in my view, an important challenge an environmental educator is facing.

Although desirable from an environmental point of view, it cannot be guaranteed that students' values, beliefs, attitudes and behaviors will change into an environmentally sound direction. Even when students' values, beliefs and attitudes do change into that direction, it still does not mean their behavior will change likewise. The relationship, for instance, between attitudes and behavior is more complex than many environmental educators think (e.g. Lucas, 1980a,b; Fishbein and Ajzen, 1980).

Some educators/researchers (e.g. Stapp and Di Chiro, 1985; Robottom, 1985) take a different approach to EE in school-settings. They suggest that more success can be achieved when teachers and students are engaged in a "problem-solving" or "situation-improving" process on an equal base. Drawing upon Lewin's Action Research, they suggest the following role for students within EE: '...students should be involved directly in the environmental problem solving process (directed to a problem which they themselves have identified, AW) in the classroom. They should also be involved in reflection on personal feelings and values regarding the learning process they are experiencing. They should consider different aspects that influence this experience including; themselves, the teacher, the school, the administration, the community,...parents and significant others' (Di Chiro and Stapp, 1985; 235).

So far the importance of values and their attributes within EE have been stressed. Two dilemma's that arise when giving education with a strong change component (EE <u>for</u> the environment) have been presented and discussed.

When reviewing some recent Dutch articles on EE in secondary schools, one may notice a, what I call, cognitive trend in EE (Boersma, 1986; Van der Loo, 1986). Without denying the importance of values, beliefs and attitudes, it is being suggested that strong emphasis should be placed on the trans-

mission of knowledge and insights. Although it is not what the authors aim for, we then may very well maintain traditional science education but now provided with an "environment" label.

Lucas (1980a) notices that science is sometimes seen as a vehicle for promoting EE, sometimes as the central activity within EE, and other times as a component of EE. '...the environment may be seen as providing an organizing theme in science courses; and there are examples of EE providing a vehicle for developing themes about science, particularly as a method of demonstration or discussing the social responsibility of scientists' (Lucas, 1980a; 5).

In paragraph 2.3 I have already critized traditional science education and argued that it is an insufficient base for the development of EE in Dutch secondary schools. I have argued in this paragraph that education for the environment requires a different approach to education. Not only because it is concerned with "wholes" rather than with "parts", but also because of its change component.

Considering; the shortcomings of traditional science education, the characteristics of EE, the warning of popularizing science courses with an "environment" label and the need for maintaining the existing disciplines -on pratical grounds and grounds of disciplinary understanding- I suggest to develop an "environmental core curriculum" (Fensham and May, 1979) that is internally sound. Internally sound in the sense that all disciplines;

- learn to speak each others (or perhaps one universal) language,
- let go of disciplinary chauvinism (Lucas, 1980a,b; Frischknecht and Brandenburg, 1981) and complement reductionism with "holism", occasionally inclusing other disciplines,
- pay attention to the relations between science - technology - society from both an anthropocentric and an ecocentric point of view,
- start the learning process with the ideas, beliefs and perceptions students' bring into class and continuously build upon those,

- no longer ignore processes that are crucial for education <u>for</u> the environment (including; values-clarification, opinion-forming and problem-solving).

2.5 Toward a Superordinate Goal for Environmental Education

After comparing various superordinate goals in table 2.1 and paying special attention to EE in the formal educational system, I now come to formulating a superordinate goal of EE.

Whereas EE should complement reductionism, it should take a holistic approach. Whenever possible it should take the environment as a whole at the core of content. This implies a school structure that allows an interdisciplinary approach.

Whereas EE is education <u>for</u> the environment as well, it should focus on; knowledge, insights, values, awareness, attitudes and skills that clearify the relationship between man and his environment, and that may contribute to the improvement of this relationship.

Whereas the union of theory and practice and being acquainted with democratic principles are of crucial importance to education in general, EE too should actively link school learning with the real world by involving the students in activities such as; problem solving, decision making and opinion forming.

Whereas personal development is an important goal for education in general (e.g. WRR, 1986), self reflection and becoming critical towards the world we live in, should be an essential part of EE as well.

Whereas we live in an increasingly complex society with multicultural dimensions, EE should 'promote a cross-cultural direction in education in order to increase the understanding that we indeed live and operate in a global society' (Di Chiro and Stapp, 1985).

Whereas the nature of EE demands a new approach towards both teaching and learning, and whereas contemporary education less and less seems to prepare students for life after school, EE can make a powerful contribution to the innovation of the

educational system.

This brings me to the following superordinate goal statement:

> EE constitutes a comprehensive lifelong education that prepares the individual for life through an understanding of the major problems of the contemporary world, and the provision of skills and attributes that may play a productive role towards improving and protecting the environment with due regard given to ethical values.
> By adopting a holistic approach, rooted in a broad interdisciplinary base, it (re)creates an overall perspective which acknowledges the fact that the natural environment and man-made environment are profoundly interdependent.
> It helps reveal the enduring continuity which links the acts of today to the consequences of tomorrow.
> It demonstrates the interdependencies among national communities and the need for solidarity among all mankind by giving education a cross-cultural direction.
> It looks outward to the community, involving the individual in an active problem-solving process within the context of specific realities, encouraging initiative and a sense of responsibility.
> It encourages a critical stance towards oneself and towards the world.

As you may notice this "root-definition" is very similar to the one formulated at the Tbilisi conference (UNESCO/UNEP, 1977), indicating that there is international consensus on the content of the definition. The statement should be seen in the light of the discussions presented earlier in this chapter.

2.6 Towards Intermediate Goals of Environmental Education

I will now present some intermediate goals of EE. Intermediate goals may be defined as goals that specifically state desired outcomes of EE in the classroom. In other words: they describe

the desired changes that are to occur in the students themselves, rather than in the "world". As such they are of great importance for guiding and evaluating the learning process.

Since the formulated superordinate goal is very similar to the one formulated at the Tbilisi conference, a logical next step is to look at the categories of objectives and their guiding principles, formulated at this intergovernmental conference. Therefore both will be presented in their original form as they were formulated in recommendation number two (UNESCO,UNEP, 1977; appendix).

* <u>Categories of EE objectives</u>:

<u>Awareness</u>: to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems.

<u>Knowledge</u>: to help social groups and individuals gain a variety of experiences in, and acquire a basic understanding of, the environment and its problems.

<u>Attitudes</u>: to help social groups and individuals acquire a set of values and feelings of concern for the environment, and the motivation for actively participating in environmental improvement and protection.

<u>Skills</u>: to help social groups and individuals acquire the skills for identifying and solving environmental problems.

<u>Participation</u>: to provide social groups and individuals with an opportunity to be actively involved at all levels in working towards resolution of environmental problems.

* <u>Guiding principles for EE</u>:

EE should:

- Consider the environment in its totality -natural and built,

technological and social (economical, political, technological, cultural-historical, moral, aesthetic);

- be a continuous lifelong process beginning at pre-school level and continuing through all formal and non-formal stages;

- be interdisciplinary in its approach, drawing on the specific content of each discipline in making possible a holistic and balanced perspective;

- examine major environmental issues from local, national, regional and international points of view so that students receive insights into environmental conditions in other geographical areas;

- focus on current and potential environmental situations, while taking into account the historical perspective;

- promote the value and necessity of local and international cooperation in the prevention and solution of environmental problems;

- explicitly consider environmental aspects in plans for development and growth;

- enable learners to have a role in planning their learning experiences and provide an opportunity for making decisions and accepting consequences;

- relate environmental sensivity, knowledge, problem-solving skills and values clarification to every age, but with special emphasis on environmental sensitivity to the learner's own community in early years;

- help learners discover the symptoms and real causes of environmental problems;

- emphasize the complexity of environmental problems and thus the need to develop critical thinking and problem-solving skills;

- utilize diverse learning environments and a broad array of educational approaches to teaching/learning about and from the environment with due stress on practical activities and first hand experience.

It may be argued that the Tbilisi categories of objectives are in fact general goals. The Tbilisi Declaration may be hard to translate into managable instructional objectives (Hungerford et al., 1980). Hungerford et al. therefore suggest to introduce a set of more definative intermediate goals, acknowledging the categories of objectives and the guidelines as they have been stated in Tbilisi. The superordinate goal Hungerford et al. propose can be found in paragraph 2.2 (number 8).

Since, in my opinion, their intermediate goals may be of importance for the development of EE within the Dutch educational system as well, I will now present them in their original form (Hungerford et al., 1980). The authors distinguish four levels of intermediate goals.

<u>Level I. Ecological Foundations Level</u>

This level seeks to provide the receiver with sufficient ecological foundations knowledge to permit him/her to eventually make ecologically sound decisions with respect to environmental issues.

The Ecological Foundations Level would minimally include the following conceptual components:

A. Individuals and populations.
B. Interaction and interdependence.
C. Environmental influences and limiting factors.
D. Energy flow and materials cycling (biogeochemical cycling).
E. The community and ecosystem concepts.

F. Homeostasis.
G. Succession.
H. Man as an ecosystem component.
I. The ecological implications of man's activities and his communities.

Level II. Conceptual Awareness Level-Issues and Values

This level seeks to guide the development of a conceptual awareness of how individual and collective actions may influence the relationship between the quality of life and the quality of the environment and, also, how these actions result in environmental issues which must be resolved through investigation, evaluation, values clarification, decision making, and finally, citizenship action.

Goals at this level are formulated to provide opportunities for receivers to conceptualize:

A. how man's cultural activities (e.g., religious, economic, political, social, etc.) influence the environment from an ecological perspective.
B. how individual behaviors impact on the environment from an ecological perspective.
C. a wide variety of environmental issues and the ecological and cultural implications of these issues.
D. the viable alternative solutions available for remediating discrete environmental issues and ecological and cultural implications of these alternative solutions.
E. the need for environmental issue investigation and evaluation as a prerequisite to sound decision making.
F. the roles played by differing human values in environmental issues and the need for personal values clarification as an integral part of environmental decision making.
G. the need for responsible citizenship action (e.g., persuasion, consumerism, legal action, political action, ecomanagement) in the remediation of environmen-

tal issues.

Level III. Investigation and Evaluation Level

This level provides for the development of the knowledge and skills necessary to permit receivers to investigate environmental issues and evaluate alternative solutions for remediating these issues. Similarly, values are clarified with respect to these issues and alternative solutions. Goals at this level are presented in two components.

Component A: Goals for component A are to develop in receivers:

A. the knowledge and skills needed to identify and investigate issues (using both primary and secondary sources of information) and to synthesize the data gathered.
B. the ability to analyze environmental issues and the associated value perspectives with respect to their ecological and cultural implications.
C. the ability to identify alternative solutions for discrete issues and the value perspectives associated with these solutions.
D. the ability to autonomously evaluate alternative solutions and associated value perspectives for discrete environmental issues with respect to their cultural and ecological implications.
E. the ability to identify and clarify their own value positions related to discrete environmental issues and their associated solutions.
F. the ability to evaluate, clarify, and change their own values positions in the light of new information.

Component B: Goals for Component B are to provide receivers with opportunities to:

G. participate in environmental issue investigation and evaluation.

H. participate in the valuing process in a manner as to permit the receiver to evaluate the extent to which his/her values are consistent with the superordinate goal of achieveing and/or maintaining a dynamic equilibrium between the quality of life and the quality of the environment.

Level IV. Environmental Action Skills Level- Training and Application

This level seeks to guide the development of those skills necessary for receivers to take positive environmental action for the purpose of achieving and/or maintaining a dynamic equilibrium between the quality of life and the quality of the environment. Goals at this level are presented in two components.

Component A: The goal for Component A is to develop in receivers:

A. those skills which will permit them to effectively work toward ends which are consistent with their values and take either individual or group action when appropriate, i.e., persuasion, consumerism, political action, legal action, or ecomanagement.

Component B: The goals for Component B are to provide receivers with opportunities to:

B. make decisions concerning environmental action strategies to be used with respect to particular environmental issues.
C. apply environmental action skills to specific issues, i.e., to take citizen action on one or more issues.
D. evaluate the actions taken with respect to their influence on achieving and/or maintaining a dynamic equilibrium between the quality of life and the quality of the environment.

Hungerford, Peyton and Wilke (1980) made the following assumptions relative to the goals (again these are presented in their original form):

1. That the goals for curriculum development in EE are appropriate for use in guiding both formal and nonformal EE curriculum development efforts.

2. That a "receiver" can be thought of as any person, of any age, who can be reached through either the formal or nonformal educational sectors.

3. That the superordinate goal is philosophically correct as stated. That this goal presents the most appropriate direction for environmental education if EE is going to meet the tremendous challenges facing mankind both today and tomorrow.

4. That ecological foundations are critical to any EE program as prerequisite or corequisite cognitive knowledge. That ecological concepts are an integral part of EE. Despite this premise, it remains cogent to make certain that receivers distinguish between environmental education and ecology per se.

5. That regardless of the importance of methodologies such as outdoor education, environmental interpretation, acclimatization, and outdoor recreation, these are not a part of the substantive structure of EE per se. Therefore, ancillary goals representing these activities do not appear here although a number of the goals for curriculum development in EE might be facilitated by the use of these and other methodologies.

6. That some level of "environmental sensitivity" is probably critical to the receiver's being willing and/or able to engage profitably in Levels II, III, IV of this set of goals. Irrespective of this assumed prerequisite, the developers have arbitrarily omitted goals dealing with sensitivity on several grounds. These are:

A. Sensitivity would have to be presented as foundational.
B. Sensitivity per se cannot be operationalized in a manner as to provide for any measurable criterion level or affect.
C. Every individual will enter the EE process with a unique set of affective predispositions, generated by the individual's own background of experiences.
D. Like values clarification, sensitivity will, in part, result from EE activities themselves. In particular, judiciously developed instructional programs in ecological foundations and conceptual awareness should measurably assist in the sensitization process.

7. The process of valuing, values clarification, and moral reasoning are implicit in the goals, particularly Levels III, and IV.

8. That environmental action is, in fact, represented by the five categories of action as stated in the goals (or in combinations of these categories). The assumption is also made that these action categories (or combinations of them) are exhaustive.

9. That the concept of maintaining and/or achieving a dynamic equilibrium (homeostasis) must be interpreted from both cultural and ecological perspectives. That said equilibrium may well result in a distinct compromise between the quality of life on one hand and quality of environment on the other. The curriculum developer must be constantly aware of this in order to produce curricular materials that look rationally at both the cultural and ecological costs involved in achieving a true equilibrium.

10. That the phrase "...to provide receivers with opportunities to apply environmental action skills to specific issues" implies no more than what is stated. That an educator cannot ethically force a receiver to take action but, instead, should provide mechanisms whereby action can be taken if

desired.

11. That instructional objectives would be generated under each subordinate goal during curriculum development.

12. That EE is an interdisciplinary pursuit and that numerous disciplines must be reflected in the generation of any set of goals for curriculum development. Only in this manner can EE help receivers to succesfully meet the challenges facing them as world citizens.

In my opinion many of the problems/dilemma's for EE which have been put forward previously, have been dealt with adequately in the goals and assumptions as stated by Hungerford at al. However, before putting them into educational practice we need to take a closer look at; how students actually learn, how to teach the world as a whole, and some philosophical foundations/implications.

In the next three chapters the educational side of EE therefore will be elaborated. Two central features presented in this chapter will be taken at the base of looking at the educational side of EE:

1. Every individual will enter the EE learning process with affective and cognitive predispositions, generated by the individuals' own background. These predispositions (similar to the alternative conceptions, mini-theories, ideas, frameworks, etc., mentioned in paragraph 2.3) should continuously be at the center of the learning process. In chapter three it will be argued that these predispositions, acquired through prior interaction with both the social and physical environment, more than anything else determine what student's really learn and believe.

2. An essential feature of EE is its attempt to see the world as a whole. Consequently concepts such as ecosystems, equilibrium, interrelatedness, interdependency, homeostasis, succession, material cycling, self generation, feedback, return

in many EE objectives. A major problem when teaching the earth as a whole is: How to deal with organized complexity? In chapter four it will be argued that some systems approaches may be valuable for EE; as a mode of thinking, as a way of managing the content of EE, and as a way of organizing the educational system in which EE is to take place.

2.7 Conclusions and Abstract

Seemingly small differences in superordinate goals of EE may hide varying worldviews and consequently lead to significantly different EE programs. Differences may occur in both the core of content of EE and in its desired outcomes. Table 2.1 provides an overview of some of the differences between twelve superordinate goals for EE.

It is important to achieve some consensus on the goals of EE, especially when practicing EE within the formal educational system. Without a clear statement of goals an EE program may easily become a series of unrelated experiences focusing on limited program objectives.

It has been argued that traditional science education needs to be changed first before it is able to serve as satisfactory base for the development and implementation of EE within Dutch secondary education. EE is fundamentally different from traditional science education in that it should:

- teach the world as a whole (as opposed to reductionism).
- link its content to the students' own real world experiences.
- focus on the way science, technology, society and environment relate.
- continuously draw on the ideas, beliefs and perceptions students bring into class.
- be education <u>for</u> the environment <u>in</u> the environment, rather than education about the environment.

Some dilemma's concerning EE <u>for</u> the environment have been presented. It has been argued that value clarification, problem solving, participation, decision making and opinion forming are as important objectives of EE as transfering knowledge and insights. Furthermore it has been stated that by its very nature EE can make a powerful contribution to the innovation of the educational system.

A superordinate goal (statement) has been put forward. In the last paragraph the categories of objectives and guidelines as they were formulated at the Tbilisi conference, have been presented. Finally some intermediate goals for curriculum development in EE as they have been stated by Hungerford et al., were put forward as well.

It has been argued that constructivist approaches of learning and systems approaches need to be elaborated when studying the educational side of EE, for, as it seems, they can greatly contribute to the development of EE. This will be explored in the chapters hereafter.

CHAPTER THREE: A CONSTRUCTIVIST APPROACH OF LEARNING; IMPLICATIONS FOR ENVIRONMENTAL EDUCATION

3.1 Introduction

Constructivist approaches of learning regard students as people who already posses some knowledge and skills determining to a large extent what they are able to learn at a given moment. Students actively construct their own meaning in an attempt to make sense of the world. This view opposes the view of students as passive learners who are able to "absorb" the concepts offered by the teacher in the way intended by the teacher.

Constructivism has its roots in the epistemology of the interpretive Verstehen tradition (Weber, 1949 in: Driver and Oldham, 1986) which has at its center the importance of meaning as constructed by individuals in their attempt to make sense of the world. Thus, the sense made of any event is regarded to be dependent not only on the situation itself, but also on the individual's purposes and active constructions of meaning. These constructions are seen as tentative models which are continually tested against experience and, if necessary, modified.

The tradition is concerned with the intents, beliefs and emotions of students as well as their conceptualizations. Furthermore it recognizes the influence that prior experience has on the way phenomena are perceived and interpreted (Driver, Oldham, 1986).

Magoon suggests that in the light of the Verstehen tradition '...the researcher (possibly any individual, AW) is in a position much like a member of the audience in a play; attempting to pull together hints, consistencies, and patterns in order to answer the question: What did the actor mean by that?' (Magoon, 1977; 661).

Piaget could be described as a constructivist since he was concerned with the way children construct knowledge. He recognized the importance of the "self-regulation" process in individual learning (Driver and Oldham, 1986). Boersma notes, how-

ever, '...that Piaget's idea that age-linked phases can be distinguished in children's cognitive development is now largely considered to have been superseded' (Boersma, 1986; 10, also: Posner et al., 1982; Nussbaum and Novick, 1982; Hasweh, 1986).

Constructivist educational researchers generally view learning as the way conceptions change. In his theory of meaningful learning, Ausubel (1968) suggests that if a new piece of information or concept can be integrated or subsumed into an existing cognitive structure, it is more likely to be accepted. It was Ausubel who wrote: 'The most important single factor influencing learning is what the pupil already knows' (Ausubel, 1968; vi). Ausubel's work has been further developed and refined by Novak and Gowin (e.g., Novak, 1977, 1978; Novak and Gowin, 1984).

To a certain degree learning processes, from this point of view, show similarities with Kuhn's "scientific revolutions" (e.g. Kuhn, 1970). Kuhn has pointed out that the history of science shows the changes that have occured in the concepts through which scientists view reality. Novak illustrates this with the following example: 'An Aristotilian sees rocks as falling to the earth because that is where rocks seek to go, whereas a contemporary physicist views the earth and the rock moving together at a rate determined by their masses and velocities, and by the distance between them. Both views are interpretations or "conceptual goggles", but, unlike the Aristotilian view, the modern view explains why a rock (or satellite) can stay in orbit around the earth' (Novak, 1977; 22).

Kuhn has described the role of these "interpretations", or paradigms as he named them, in guiding the work of scientists. According to Kuhn a "scientific revolution" occurs when the basic assumptions of the existing paradigm are being challenged. If inquiry is to proceed, scientists must acquire new concepts and a new way of seeing the world (Kuhn, 1970).

Posner et al. believe that there are analogous patterns of conceptual change in learning. 'Sometimes students use existing concepts to deal with new phenomena, whereas other times the students' current concepts are inadequate to allow him to grasp

some new phenomenon successfully' (Posner et al., 1982; 212). In the latter case the student must replace or reorganize his or her central concepts (Kuhn's scientific revolution).

This view contrasts the views of philosophers who place central emphasis on the research methodology used by scientists. Popper (1959), for instance, minimizes the conceptual framework of the scientists and stresses instead the scientists' methods of analysis, as if they are independent of interpretations ("value-free science").

Posner et al. argue that whenever the learner encounters a new phenomenon, he/she must rely on his/her current concepts to organize his/her investigation. 'Without concepts the world is and remains...blooming buzzing confusion' (Posner et al., 1982; 213). They refer to those concepts, which govern a conceptual change, as a "conceptual ecology", borrowing a phrase from Toulmin (1972).

They too acknowledge that views of conceptual change oppose traditional empiricism. 'Empiricism's central commitment, that there is nothing in the mind not first in the senses, requires people to be able to learn something in the total absence of any prior concepts. We believe this to be impossible. A mind which began as a blank tablet would remain so, for it would lack the means to investigate experience' (Posner et al., 1982; 213). For some speculations about the origins/sources of concepts I refer to Driver and Erickson (1983).

Gilbert and Watts (1983) notice similar developments in science, psychology and sociology. Developments from, what they call, realism, associated with the Erklaeren tradition, to relativism, associated with the Verstehen tradition. The Erklaeren (explanation) tradition is connected to the empirical inductivist view of knowledge, with a firm belief in the value of a reductionist approach to phenomena, using replicable experimental methods in the search for causal mechanisms. The Verstehen (understanding) tradition here is connected to post-inductivist views of knowledge, with a belief in the value of an holistic approach to phenomena, seeking to perceive understanding as shown by the individual actors in any human situation without the overt pursuit of generalizations.

Gilbert and Watts argue that these two traditions have become reflected in two paradigms in educational research; the traditional paradigm and the non-traditional paradigm. The special features of these paradigms are shown in table 3.1.

Table 3.1 Two paradigms in educational research

TRADITIONAL PARADIGM (Erklaeren Tradition)	NON-TRADITIONAL PARADIGM (Verstehen Tradition)
- Scientific (realism)	- Artistic (relativism)
- Experimental (controled situations)	- Naturalistic (natural occuring situations)
- Prescriptive (determining future outcomes)	- Descriptive (no overt intension of studying future action)
- Quantitive (suitable sections of a general population are studied)	- Qualitative (phenomena without undue regard to their typicality are studied)
- Nomothetic (general laws are sought)	- Idiographic (study of individuals)

free after Gilbert and Watts, 1983

From the above it can be concluded that in general constructivists view learning as conceptual change, seeking support from the Verstehen tradition (table 3.1). Concepts are considered to stand at the base of learning. Therefore it is very important to obtain (construct...) a clear concept of concepts. Also because there is some ambiguity to be recognized in the way constructivists use the word concept. This ambiguity can be brought back to the two paradigms distinguished in table

3.1.

In their publication about concepts, misconceptions and alternative conceptions, Gilbert and Watts (1983) distinguish three views of concept of which two will be elaborated here.

1. <u>The 'classical' view of concept:</u>

In the classical view of concept all instances of a concept share common properties which are necessary and sufficient to define the concept. An underlying assumption is that knowledge is stored in the mind in hierarchical layers which can be decomposed into smaller parts and studied independently. 'Transferred to the area of educational instruction these assumptions imply that the process of acquisition of knowledge is decomposable into elementary steps that can be represented by hierarchical decision trees, so that progress in knowledge is dependent on whether the previous step is mastered in its entity: whether it's right or wrong' (Gilbert and Watts, 1983; 66).

Such a model is used by, for instance; Ausubel (1968), Gagne (1970) and Novak and Gowin ('concepts are regularities in events or objects designated by some label', 1984). Public and private knowledge are seen as isomorphic and by implication are part of a <u>static</u>, logical and organized system.

The classical view of 'concept' gives rise to the notion of mis-conceptions; 'a flaw in the system' (Gilbert and Watts, 1983; 66). According to Gilbert and Watts, in science education research the program of detecting and illuminating misconceptions can be seen as an initial step in an effort to isolate, eliminate or repair and restore the failures in the analytical framework in order to continue accretion on "solid foundations".

The classical view of concept in the light of what has been said above, is connected to the traditional paradigm and the Erklaeren tradition.

2. <u>The "actional" view of concept</u>

The actional view of concept is a view of concepts as being active, constructive and intentional. Freyberg and Osborne (1981) present concepts as ways of organizing our experiences so that the new experiences do not leave concepts intact but that all cognitive learning involves some degree of re-conceptualizing our existing knowledge. In this light conceptual development can be seen as a continuous, active, creative process of differentiation and integration of local conceptual domains (also: Kelly, 1963).

This perspective leads to a research program which is sharply different from that associated with the classical view. Rather than a search for invariants (or "universals") in either conceptual content or development, it becomes one of mapping the "topography" of local domains of understanding, or mini-theories (Claxton, 1982), and of charting changes in frames of reference so that the durability, stability, coherence and consistency of conceptual constructions become the point of departure. Gilbert and Watts therefore see the actional view as being associated with the non-traditional paradigm and the Verstehen tradition.

One crucial aspect of the actional view of concept is the high epistemological status accorded to an individual's personal conceptions. For instance the phrase "children's" science (Gilbert, Osborne and Fensham, 1982) accords to children's views the status that society frequently gives to science, and recognizes that such views are developed using notion of "scientific method". The view is highly supportive of valuing and respecting personal meanings in order to enhance learning.

This view of concept has one immediate consequence; there are no mis-conceptions. "Students errors" are then recognized as being natural developmental phenomena -personally viable constructive alternatives- rather than the result of some cognitive deficiency, inadequate learning, "carelessness" or poor teaching (Gilbert and Watts, 1983). Gilbert and Watts note that this outlook supports Kelly's (1955) theoretical position in that it is an essential, unavoidable and desirable feature of personal experience that individuals generate their own varied conceptions for phenomena.

I have presented two contrasting views of concept associated with respectively the Erklaeren tradition and the Verstehen tradition. I have previously argued that there are some serious shortcomings in the Erklaeren tradition and that the Verstehen tradition offers a more promising perspective for innovation of science education and, as will be argued later on in this chapter, for EE as well.

In this light the view of concept I will use from now on will be the actional view of concept. This view is supported by Driver and Bell (1986); Gilbert, Osborne and Fensham (1982); Posner, (1982); Osborne and Wittrock (1983); Nussbaum and Novick (1982); Osborne and Gilbert (1980); Posner, Strike, Hewson and Gertzog (1982); Driver and Oldham (1986), Hasweh (1986); and Driver, Guesne and Tiberghien (1986).

It should be noted that Gilbert and Watts distinguish a third concept of view namely: "the relational" view of concept, which is intermediate to the classical and actional view (Gilbert and Watts, 1982).

I will now take a closer look at how learning in the constructive sense takes place.

3.2 Theories of Conceptual Change

It has been previously argued that children develop ideas and beliefs about the natural world before they are formally taught. The views and ideas that students hold, have been given a number of names including alternative frameworks, children's science, alternative conceptions and mini-theories. They all stem from a constructivist epistemology that assumes that learners actively generate meaning from experience, and that learning is the process of conceptual change. This paragraph presents some ways of looking at the way conceptions change.

Driver and Oldham note that '...one significant finding is that some of the ideas used by children about the natural world are firmly held and often persist, despite science teaching ... Thus although for some children taught scientific ideas may be

applied in stereotyped school-contexts, for example in examination questions, such ideas are not applied outside the formal school setting to explain every day phenomena' (Driver and Oldham, 1986; 106).

Most of the research outcomes I will discuss origin from research in science education. The goal of constructivist research in science education may be stated as developing a theory of conceptual change which will lead to a teaching learning sequence that starts with the student's ideas in science and has as a final result true acquisition of scientific concepts.

Although this is not the, or a, goal of EE, it is very likely that students also have ideas about environmental related topics (such as; pollution, conservation, energy, recycling, etc.). Therefore it should at least be of interest to EE research to look at theories of conceptual change derived from science education research and (cognitive) psychological research.

Rumelhart and Norman (1981) suggest three ways in which cognitive structures may change:

- through <u>accretion</u>; the addition of parts to an existing structure,
- through <u>tuning</u>; involving small modifications to an existing structure,
- through <u>restructuring</u>; involving major changes in the structuring of knowledge.

Posner, Strike, Hewson and Gertzog (1982) suggest that a number of conditions need to be met if conceptual change is to take place. They call radical conceptual change, which is comparable with Rumelhart and Norman's restructuring; "accommodation" (which they compared with Kuhn's scientific revolution). When students use existing concepts to deal with new phenomena they speak of "assimilation" (comparable with Rumelhart and Norman's accretion and tuning). The authors note that these are Piaget's words, but they do not intend any commitment

to his theories.

Posner et al. distinguish four important conditions which must be fulfilled before accommodation is likely to occur:

(1) <u>There must be dissatisfaction with existing conceptions</u>.
'Scientists and students are unlikely to make major changes in their concepts until they believe that less radical changes will not work.'

(2) <u>A new conception must be intelligible</u>.
'The individual must be able to grasp how experience can be structured by a new concept sufficiently to explore the possibilities inherent in it.'

(3) <u>A new conception must appear initially plausible</u>.
'Any new concept adopted must at least appear to have the capacity to solve the problems generated by its predecessors. Otherwise it will not appear a plausible choice. Plausibility is also a result of consistency of the concepts with other knowledge'

(4) <u>A new concept should suggest the possibility of a fruitful research program.</u>
'It should have the potential to be extended, to open up new areas of inquiry.' (Posner et al., 1982; 214)

Hasweh (1986) divides the process of conceptual change in the following (sub)processes:

(1) An old conception should be discarded or limited in its use.
(2) A new conception should become accepted.
(3) A conflict between the old conception, other knowledge and beliefs and past experience on the one hand, and the new conception on the other hand should be resolved.
(4) The new conception should become available to interpret new experience when appropriate in the future.

(after: Hasweh, 1986; 230)

According to Hasweh the problem of conceptual change becomes that of identifying the following factors;

- persistence of (pre)conceptions,
- acquisition of new conceptions,
- cognitive restructuring.

Hasweh criticizes the model presented by Posner et al. (1982) by arguing that 'the model falls short only in that it does not adequately emphasize the distinctions between the psychological processes leading to change and the external conditions related to them' (Hasweh, 1986; 230). The next three (sub)paragraphs will respectively deal with the factors influencing persistence, acquisition and restructuring of conceptions or concepts.

3.2.1 Persistence of Preconceptions

Why do students often hold on to their own explanations/ ideas of the phenomena occuring in the natural world, even when they are taught "scientific" conceptions that "seem" to make more sense?

There appears to be consensus among constructivists on the idea that children acquire considerable knowledge about the natural and technological world from their contact with the social and physical milieu (e.g. Ausubel, 1968; Kelly, 1969; Osborne and Wittrock, 1983).

The nature of the views children hold supports the comments of Champagne, Klopfer and Anderson (1980) that children do not have isolated ideas, but rather ideas that make up parts of conceptual structures which provide a sensible and coherent understanding of the world from the child's point of view (the nature of thinking is holistic...).

Another finding presented by Osborne and Wittrock (1983) is that the views of the world and meanings for words held by some younger children, which differ from the scientist's viewpoint, are also held by older students who have had considerable expo-

sure to science teaching! This supports Ausubel's view that children's ideas can be amazingly tenacious and resistant to change (Ausubel, 1968).

Why are students' ideas so persistent? Claxton (1984), in acknowledging the strongly individual character of constructing meaning, suggests that conceptual change can be potentially threatening to the individual and that restructuring conceptions requires a supportive environment where the individuals's ideas are valued.

Hasweh (1986) notes that students' (pre)conceptions take the form of procedural knowledge -as opposed to declaritive knowledge- which is persistant to change. Hasweh speaks of procedural knowledge when (pre)conceptions are used for interpreting events automatically and at the "unconcious" level.

Hasweh also argues that since conceptions are directly abstracted from experience with the world, they cannot be completely "wrong" (also Posner et al., 1982), but are adequate for certain purposes within a limited domain of the world. He takes students' pre-Newtonian conceptions as an example. In a world full of friction, objects do need to be pushed to move, they usually move in the direction of these "pushes", and finally come to rest once we stop pushing them. So the notion that velocity is proportional to force is quite adequate for interacting with objects...

It has also been argued by various researchers that students develop assimilative "strategies" that help in the persistence of conceptions. For instance:

- Looking for confirming, rather than opposing, evidence to test ones own theory or conception (Snyder and Swann, 1978; Linn and Swiney 1981).
- Refusing counter evidence. Lord et al.(1979) showed that subjects who read two studies, one supporting their critical position and one opposing it, accepted the supporting data at face value while they critically examined the opposing study.
- Considering the anomaly as an exception to the rule and remembering it as such (Hasweh, 1986).

- Using ad hoc explanations and rationalizations (Hasweh, 1986).

Up until now only some internal factors affecting persistence have been identified. Hasweh assumes that once these have been identified it becomes possible to examine society as a whole and classroom life in particular, to identify conditions allowing these internal factors to play a role. He argues that the assimilation strategies, as well as other cognitive processes, might be viewed as common sense epistemology and methodology for validating knowledge. 'The external conditions affecting persistence depend on whether this epistemology is challenged and whether an alternative scientific epistemology is taught or not' (Hasweh, 1986; 235).

Posner and Strike (1982) did research on the way students' knowledge about knowledge (meta-knowledge) influences their performance in physics. They found that: 'People who believe the world to be a rational place, who believe objective knowledge is possible, who demand a consistence between theory and experience, and who are willing to see their world through the conceptual eyes of well-confirmed theory do physics better' (Posner and Strike, 1982; 34).

Some factors that affect persistence are:

(1) Teachers are unaware of students' (pre)conceptions (e.g. Tasker 1981, Anderson and Smith, 1983).
(2) Evaluation methods (e.g. examination questions) do not capture (pre)conceptions or assimilation of new knowledge into existing conceptions. This is indicated by studies that show that students pass courses with good grades yet retain their preconceptions. Most tests reveal whether the required answer is provided or not, but fail to examine the conceptions held that can explain "wrong" answers (Hasweh, 1986).
(3) (Pre)conceptions are not addressed even when revealed by students' answers. Teachers are not critical of answers revealing preconceptions (Anderson and Smith, 1983).

In addition to these classroom related factors there are factors in the larger environment that help persistence. Atkin and Karplus (1962) pointed out that society as a whole supports the persistence of these beliefs. Hasweh distinguishes three factors leading to such persistence:

(1) The existence of explicit cultural beliefs
Explicit cultural beliefs that are in conflict with orthodox scientific conceptions and reinforce students' preconceptions, exist both in Western and in other societies. They range from religious explanations and mythology to the body of knowledge in many practical fields.

(2) Language
The every day use of language tends to be subtly different from the language of science particulary with regard to basic and important words, like animal, friction, force, sunset and sunrise. (Osborne, Bell, Gilbert, 1982 in: Osborne and Wittrock, 1983) Words as sunset and sunrise for instance contribute to the (pre)conception that the earth is the center of the universe (Nussbaum, 1979).

(3) The persistence of common sense epistemology in the culture as a whole
'Common sense epistemology is prevalent in most cultures, probably because it is adequate for most purposes encountered in daily life. Other forms of validating knowledge have been created for the specific purposes of scholarly activities within the different disciplines and cannot be expected to be prevalent among society as a whole or to be relevant to the practical purposes of daily life' (Hasweh, 1986; 238).

I have attempted to bring together factors that contribute to the persistence of (pre)conceptions inspite of teaching, that have been mentioned by various constructivist science education researchers. They can be divided in internal (psychological) factors and external factors (environmental) fac-

tors. They all need to be studied if one wants to induce conceptual change that leads to the (lasting) acceptance of a new conception. I will now review the way new conceptions are acquired.

3.2.2 Acquisition of New Conceptions

I have already mentioned the four conditions distinguished by Posner et al. (1982) under which accommodation -which in my view is very similar to the acquisition of <u>new</u> conceptions- may take place. In short: dissatisfaction with existing conceptions, new conceptions must be intelligible, new conceptions must be initially plausible, and new conceptions should suggest the possibility of a fruitful research program.

It has been previously argued that an individual's current concepts will influence the selection of a new central concept. Posner et al. (1982) have suggested that the following kinds of concepts are particularly important determinants of the direction of an accommodation:

(1) Anomalies: The character of specific failures of a given idea are an important part of the current concept which selects its successor.
(2) Analogies and metaphors; these can serve to suggest new ideas and to make them intelligible.
(3) Epistemological commitments:
    a) explanatory ideals; most fields have some subject matter specific views concerning what counts as a successful explanation in the field,
    b) general views about the character of knowledge; some standards for successful knowledge such as elegance, economy, parsimony, and not being *ad hoc* seem subject matter neutral.
(4) Metaphysical beliefs and concepts:
    a) metaphysical beliefs about science,
    b) metaphysical concepts of science.

(5) Other knowledge:

a) knowledge in other fields,

b) competing concepts; one condition for the selection of a new concept is that it should appear to have more promise than its competitors.

(Posner et al., 1982; 214/215)

Hasweh (1986) once again distinguishes internal (psychological) factors and external factors or conditions. He mentions two psychological factors that he considers to have importance for the acquisition of a new conception. Namely; the role of <u>experience</u> in schema induction and the relationship between the purpose of learning and the products of intellectual activities.

For a full explanation of these two factors, I refer to Hasweh's article "Toward a Explanation of Conceptual Change". For now I will confine myself to remarking that in the first case a process of mapping occurs of finding similarities between the concrete and the abstract. 'A child, for instance, seeing many people over a certain period of time finally induces the concept of "face" ' (Hasweh, 1986; 239). Hasweh concludes: 'One is always using knowledge that has already been acquired through experience and used implicitly. In cases where this experience is lacking, activities that provide it should be planned by the teacher' (Hasweh, 1986; 240).

In explaining the second case, Hasweh notes that:'In performing any task a person is trying to achieve a certain aim, and the kind of intellectual activities she or he does, depends on the relevance of the activities to achieving that aim' (Hasweh, 1986; 241).

Once these internal factors have been identified, Hasweh continues, one needs to identify the conditions in science classrooms that enhance or inhibit concept acquisition.

Enhancement of concept acquisition requires that the new conception has been emphasized and, if necessary, prerequisite experience has been provided. When these two conditions are not fulfilled it is likely that inhibition will occur. The factor of purpose plays an important role here as well. 'It becomes necessary to examine science classrooms to determine the degree