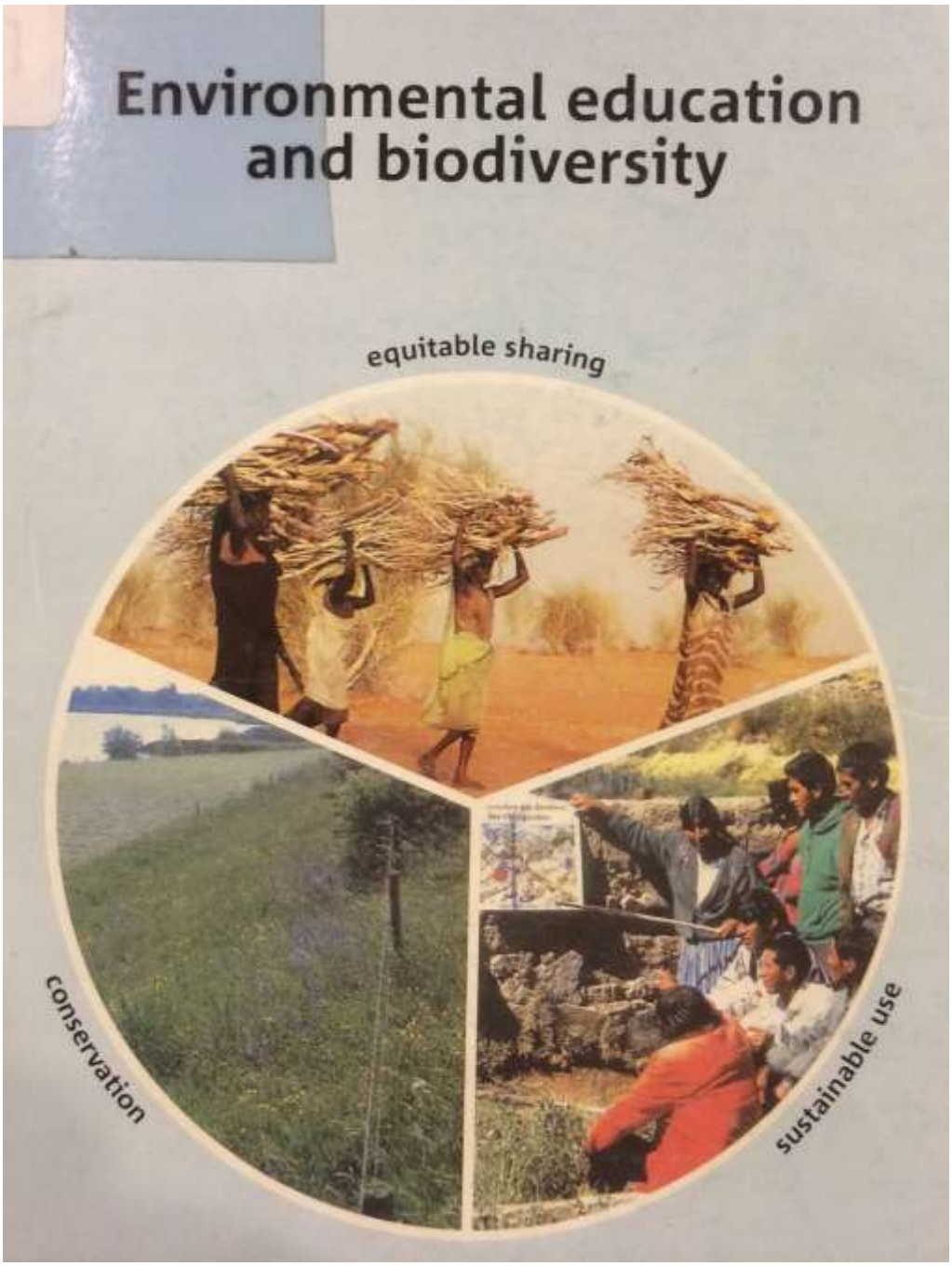

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ABSTRACT

In a research project financed by the Dutch Ministry of Agriculture, Nature Management and Fisheries, the Wageningen Agricultural University and the Utrecht University jointly investigated the various meanings, values and uses of biodiversity in order to tap its educational potential more fully. Based on interviews with various experts, a literature review and a Delphi-study, a procedure was constructed for developing the theme of biodiversity within environmental education programmes. Despite all the confusion about biodiversity, one thing is clear: there is no one single perspective or definition of biodiversity that accurately describes it in all situations or contexts. Biodiversity can have different meanings depending on the user and the context in which it is used. Even within the scientific arena a great number of biodiversity meanings and interpretations can be distinguished. It is not uncommon to find that scientific, political and symbolic meanings are used interchangeably by the same person. Both the knowledge base and the value base of biodiversity are variable and to a degree unstable and questionable.

Although these characteristics of biodiversity can render the concept useless or reduce it to a rhetorical instrument, they can also add to its strength when handled with care. Certainly from an environmental education perspective, but also from a policy-making perspective, these characteristics offer some worthwhile advantages: 1) Biodiversity brings together different groups in society that are searching for a common language to discuss nature conservation issues in relation to sustainability issues. 2) This dialogue allows the socio-scientific dispute character of “science-in-the-making” to surface. Participation in such a dispute is an excellent opportunity to learn about a highly relevant, controversial, emotionally charged and debatable topic at the crossroads of science, technology and society. 3) Making such a concept meaningful to the lives of citizens requires a procedure that could be utilised when developing educational programmes that focus on similar topics (i.e. education for sustainability).

This book provides a justification and rationale for developing biodiversity as a leading concept for environmental education for human development. Furthermore it proposes a stepping stone procedure that recognises the socio-scientific dispute character of biodiversity and provides a tool for turning biodiversity into a meaningful and existentially relevant issue. The procedure includes the following steps: analysing meanings of biodiversity, determining one or more perspectives based on the general learning goals of environmental education, setting specific learning objectives, selecting (sub)themes for learning, contextualising biodiversity and establishing the value of biodiversity. The procedure is intended to help curriculum developers, teachers, educational support staff and environmental educators give specific meaning to biodiversity and to help learners critically analyse the way biodiversity is used in science, technology and society. The procedure is an intermediate product that offers direction in developing and

implementing specific learning activities and materials for various groups of learners.

FOREWORD

One of the outcomes of the Earth Summit held in Rio de Janeiro in 1992 was the Convention on Biological Diversity. In brief, this convention promotes the sustained conservation and use of biological diversity and the equitable distribution of the benefits this diversity offers to humanity. Article 13 commits countries that signed the convention to use education and extension to help realise the convention's ambitious goals. It can be argued that, without exaggeration, the convention focuses on very complex concepts and issues. From a biological perspective we tend to speak of biodiversity in terms of variation at the levels of genes, species and ecosystems. But this is only one perspective among many. In the arenas of science, politics and society, there are other perspectives that emphasise, for instance, issues of "equitable distribution" of the world's resources and "sustainable use". It is clear that, no matter how complicated, the quality of the (natural) environment is, in one way or another, of everybody's interest.

Bearing in mind the consequences for the Dutch government of signing and ratifying the convention, the Ministry of Agriculture, Nature Management and Fisheries supports the development of educational programmes that focus on biodiversity. Such programmes are more likely to be successful when they are grounded in both theory and practice. Therefore the Ministry asked the Wageningen Agricultural University and the Utrecht University to jointly lay the foundations for the development of biodiversity as a theme for environmental education. A two-year study explored the various meanings, values and uses that are associated with biodiversity. Furthermore, the contexts in which biodiversity might blossom as a theme for environmental learning were investigated as a prerequisite to making the theme existentially relevant to the lives of 'ordinary' citizens, old and young alike. The main goal of this exploration and investigation is to tap the educational potential of biodiversity more fully.

This book represents and builds upon the main outcome of this comprehensive study. It offers a procedure to make biodiversity a meaningful concept in a specific context. The book offers a variety of suggestions, perspectives, learning goals, contexts and examples. The guidelines offered in this document must still be translated into concrete learning activities within both formal and informal education in collaboration with practitioners and curriculum developers. I hope this book will provide you with the ideas and inspiration needed for the development of meaningful environmental education programmes with a focus on biodiversity.

J.F. de Leeuw, Director-General,
Ministry of Agriculture, Nature Management and Fisheries, The Netherlands

1 INTRODUCTION

By Arjen E.J. Wals

The global loss of biological diversity - or biodiversity - the variety of life at all levels, from the genetic code that shapes living things to plant and animal communities to the landscapes around us, has reached crisis proportions. Across the globe, rainforests, wetlands and other critical habitats are being degraded or are disappearing altogether. As they disappear, so do the species that depend upon them for survival. This loss directly threatens the livelihoods of literally billions of people in the developing world who depend upon plant and animal resources for subsistence and commerce. There is also increasing evidence that the loss of biodiversity may damage the earth's ecological balance - disturbing cycles of rain and drought, seasonal temperatures, and nutrient exchange, adversely affecting the quality of life for all people, both present and future. At the same time, the loss of natural landscapes ultimately impoverishes human culture by eroding the aesthetic values that characterise our relationship with the natural world.

World Wildlife Fund
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5 February 1996

The concept of biodiversity is receiving worldwide attention, most notably among scientists, politicians and environmental educators. In part this attention is a result of attempts by many national governments to translate the 1992 Convention on Biological Diversity (IUCN, 1994) into concrete measures and actions. The convention encourages and commits countries to act on the promise to protect biodiversity by using a variety of means, i.e. policy instruments, education, communication and research. By ratifying the convention, many national governments committed themselves to taking measures that can contribute to the protection of biodiversity.

Environmental education is an interdisciplinary field rooted both in science and societies, concerned not only with environmental literacy, but also, and perhaps foremost, with the relationship people have with their environment. As such the field cannot be immune to new trends in conservation and environmental protection. When new concepts emerge from science or society that are relevant to the relationship between people and their environment, such concepts have to be scrutinised from an environmental education perspective. We only need to look at the kaleidoscope of curriculum materials and articles on the subject of *Education for Sustainability* or *Education for Sustainable Development* to illustrate that the field responds rather quickly to emerging concepts (e.g. Fien, 1993, 1996; Huckle and Sterling, 1996; Wals, 1996). Biodiversity is likely to have a similar

impact. Already, many environmental education curriculum materials have been developed or are being developed around the world on the subject of biodiversity (e.g. Binder et al., 1995; WWF-US, 1994, in press; NAAEE-WWF, 1998).

From an environmental education perspective it is crucial to come to terms with the concept of biodiversity to prevent the kind of erosion of meaning that has affected the concept of sustainability. Environmental educators will have to gain some conceptual clarity with regard to biodiversity - disregarding for the moment the question of whether such clarity can transcend a particular context or use - by asking a variety of fundamental questions which correspond to the various learning domains of environmental education: knowledge-understanding, involvement-values, responsibility-care and, finally, empowerment-action competence. Some of these questions are: What is biodiversity? What does biodiversity mean? Does it mean the same to everybody? What are some underlying assumptions, values and ethics? What is happening to biodiversity? What are the causes? What are the consequences? What can organisations do about it? What can individuals do about it? What should we be doing collectively? What should we not be doing? How can the theme become existentially relevant to the everyday life of citizens? What should the role of education be in this regard? There are no simple answers to these questions and the answers are likely to vary with context. This book begins to answer some of these questions.

As part of a two-year study, commissioned by the Dutch Ministry of Agriculture, Nature Management and Fisheries, Wageningen Agricultural University and Utrecht University jointly investigated the variety of meanings, values and uses of biodiversity in order to tap its educational potential more fully. The results of the study – which forms the basis for most of this book – have been published earlier in the Dutch language in: Van Weelie and Wals (1998). This book expands upon the Dutch version by including paragraphs on environmental education as human development and by addressing the role of environmental literacy, scientific knowledge and socio-scientific disputes in learning about biodiversity.

This, then, is the place to acknowledge the governmental initiators of this research project, Dirk Huitzing and Chris Maas Geesteranus, both working for the Ministry of Agriculture, Nature Management and Fisheries. We, too, would like to thank the members of the scientific review panel, consisting of Kerst Boersma (chairman, Utrecht University), Petran Kockelkoren (University Twenthe), Bert van Oers (Free University of Amsterdam) and Chris Maas Geesteranus (National Reference Centre for Nature Management, secretary).

Since the empirical research underlying this book is of a qualitative nature, it is of particular importance to uncover any biases that may colour the researchers' and authors' interpretations of findings. Some of these biases can be found in the authors' views of environmental education. Chapter 2 outlines these biases as a prologue to a plea for education for human development which is: a) more

concerned with helping people navigate through the realm of possible relations people can have with the environment, b) guiding them through the arena of conflicting knowledge claims, values and interests, and c) helping them create their own pathways towards sustainability in an uncertain world. Other biases can be traced back to the authors' own educational backgrounds which range from philosophy, biology, science education to environmental science. The latter biases explain a strong emphasis in chapter 3 on environmental and scientific literacy and the development of a kind of rationale for learning about biodiversity from an environmental education perspective. This is not to suggest that emotional and political aspects of learning about biodiversity should be neglected. On the contrary, clearly (re)connecting with nature, hands-on experiential learning and learning through discovery are crucial in any environmental education programme, as is shown in chapter 4.

At the same time it must be realised that there can be no environmental quality without social equity (Agyeman, 1999). The development of empowerment, communicative competence, critical thinking and the ability to participate effectively in democratic decision-making is equally important. Chapter 4 which outlines a stepping stone procedure for giving meaning to biodiversity in specific contexts for learning, shows that the participants in the empirical study support these notions.

Three appendices follow the four chapters of this book. Appendix I provides a (methodological) justification of the empirical study that provided the basis of chapter 4. Appendix II presents the questions used in one of the research instruments used in chapter 4: the Delphi-study. Appendix III contains a bibliography of sources for further reading.

On the pages ahead ways to uncover the variety of meanings scientists, politicians and environmentalists attribute to the idea of biodiversity, will be suggested and analysed. The various ideas of biodiversity need to be "contextualised" for two main reasons: firstly, "contextualisation" is essential to the presentation of these ideas as being dependent on the scientists' approaches, i.e., the context in which they try to define their perceptions of biodiversity, and the implications of such perceptions. Clearly defined contexts are essential to the idea of a legitimate socio-scientific dispute. Accordingly, different perspectives or angles to biodiversity from an environmental education point of view are delineated, in an exemplary and, therefore, by no means exhaustive list. Secondly, well-understood, concrete contexts and situations, which are related to people's own world or to their perception of the world, contribute to the meaningful learning of a concept. In the Ausubelian-Novakian sense, they become linked to the existing body of knowledge of the learner (Novak, 1977). Specific sub-themes are therefore proposed, as examples of possible bases for such meaningful learning, anchored in the learners' own realm of experience.

The topic of biodiversity has great potential for postmodern environmental education when considering its ill-defined meaning, its socio-scientific dispute character and its ability to link science, technology and society. Its ill-defined meaning requires a procedure for making it meaningful in a specific context. Its socio-scientific dispute character requires a procedure for dealing with controversy, uncertainty, diverging values and interests, and moral dilemmas. While its potential to explore, critique and utilise separate ways or systems of knowing and understanding requires a procedure to create a rich context for learning that links scientific, technological and societal expertise and common sense.

2 ENVIRONMENTAL EDUCATION AS HUMAN DEVELOPMENT

By Arjen E.J. Wals, Art H. Alblas and M. Margadant-van Arcken

2.1 Introduction

When developing learning activities or curriculum materials for environmental education about biodiversity, a thorough reflection on what environmental education means is crucial. In this chapter we take a close look at environmental education and roughly sketch the spectrum of possibilities. The view of environmental education that emerges is more or less consistent with the view that emerges in the two chapters following. The question asked in this chapter is: what is good environmental education? And not: what is so special or important about biodiversity that makes it an important topic for environmental educators? Or: how can we include biodiversity in our environmental education programmes? The latter two questions are addressed in the chapters following.

Recently environmental education has received healthy criticism from a variety of interest groups often serving conservative political agendas. The national standards 'debate' in *Environmental Communicator*, the North American Association for Environmental Education's periodical, and scholarly debates in Volumes 2, 3 and 4 of the *Canadian Journal of Environmental Education* captures some of the critique. Stripped from the rhetoric, the debates reveal basic disagreements on 'the' goals and objectives of environmental education. These disagreements reflect different positions as to what counts as environmental education and as to what its outcomes should be. Basically, they represent different world views on the role of science and education in society (Sauvé, 1996). In this chapter we will discuss these different world views and question some of the arguments put forward by proponents of outcome-based environmental education. Alternatively we will plea for environmental education which is more process-based. We will provide two examples of anchors that can be used by teachers and curriculum developers to improve the quality of environmental education learning processes and to help them select appropriate contents. These examples have been derived from several empirical studies conducted in the Netherlands.

Generally speaking environmental education around the world has first and foremost gained importance because of its potential to contribute to the resolution of environmental issues and not because of its potential to contribute to democratic and emancipatory human development. In other words: the environmental justification has, at least up until now, outweighed the pedagogical justification. Partly this is the result of environmental education being subsidised by government and, to a smaller extent, the business community which allows for at least some control of its content and goals. What often remains is an education-

al process aimed at creating a support base for environmental policy-making and regulations among the general public on the one hand, and attempts to change the environmental behaviour of citizens on the other. We could classify this manifestation of environmental education by using the adjectives 'one-sided' and 'instrumental'. An instrumental approach to environmental education seems to contradict the whole notion of a democratic society in which citizens do not blindly copy pre- and expert determined behaviour, but instead act as critical and emancipated citizens who in the role of watchdog check the government's policies and actions. An important task of the school, for instance, is to educate *for* and *with* democracy in order to develop social competent citizens who are able to contribute to a democratic society.

From a pedagogical point of view it is undesirable that the goals of environmental education are determined by outside experts or authorities who are not an integral part of the community of learners who take centre stage in the educational process. Following Langeveld's (1972) idea of taking an emancipatory approach to the raising and educating of young people, it is crucial that these goals are internally determined by this community of learners and its individual members. This idea does not ignore the ever present societal context in which education takes place, but the learner is the point of departure of the educational process, not the societal context. In other words: the point is not so much what people should know, do or be able to do, which is the embodiment of authoritative thinking and top down management, but rather: How do people learn? What do *they* want to know and learn? What knowledge and skills should not be kept from them in their attempts to give shape and meaning to their own lives?

Unfortunately much environmental education in the Netherlands has been developed with traditional attitude-behaviour models in mind (see for instance Fishbein & Ajzen, 1980). According to such models people need lots of information about the state of the environment. This information will lead to an increase in environmental awareness which is an important prerequisite (along with, for instance, social motivation to comply) for changing one's environmental behaviour. There is, however, a growing body of research that shows that these models represent an oversimplification of reality and incorrectly assume a linear correlation between knowledge-awareness-behaviour (see for Dutch examples of this research: Pelikaan, 1996; Spaargaren, 1994). Just providing information simply is not enough to change people's behaviour.

2.2 Education, not training

One could argue that despite their good intentions, many environmental education projects seem to fall short in realising ambitious learning goals such as helping citizens become environmentally knowledgeable, skilled and dedicated people who

are willing to work individually and collectively, towards achieving a balance between the quality of life and the quality of the environment (Gigliotti, 1990; Wals, 1994a). Without always challenging the nature and content of these goals, many researchers and practitioners are trying to resolve the discrepancy between theory and practice of environmental education. Some have tried to instrumentally structure environmental education content matter and the way it is presented to students using hierarchical levels of universal goals and objectives (e.g. Hines et al., 1987; Hungerford et al., 1980; Hungerford & Volk, 1990; Knapp et al., 1997), whereas others, who seem to question the value or the status of universal goals and objectives, have put emphasis on contextual development of environmental education within the school community (e.g. Gauthier et al., 1997; Gayford, 1996; Robottom, 1987; Stapp et al, 1996; Wals, 1996).

One important presupposition we, the authors, share is that environmental education should lead to the development of autonomous thinking about issues that affect the quality of life of humans and other species. An emphasis on autonomous thinking about environmental issues, or any issue for that matter, suggests that it would be wholly inappropriate to prescribe behavioural outcomes that a learning activity or sequence of activities needs to foster (Jickling, 1992). Jickling writes that he would not want his children to be educated *for* sustainable development, because it goes against the idea of education: 1) it suggests that education then becomes *training* which is the acquisition of skills and abilities which have instrumental connotations and can technically occur through repetition and practice without leading to understanding, 2) the concept of sustainable development is contested, which makes teaching *for* it doubtful at least, and 3) the prescription of some particular outlook conflicts with the development of autonomous thinking (Jickling, 1992; 1997). In other words, the educational aspect of environmental education should be enhanced. If we want to assess the quality of environmental education we should not so much focus on the impact the learning process has on the state of the environment, but rather on the impact it has on the state of the learner. The latter requires a close look at the quality of the learning process and the conditions in which learning takes place.

At the same time, however, we do acknowledge that our planet is facing destruction as a result of symptomatic environmental problems such as; overpopulation, deforestation, excessive and hazardous waste, and the degradation of water, air and soil, which ultimately are rooted in the unequal distribution of wealth, the uninhibited strife for economic growth, and inadequate education (CEI, 1991). Again this presupposition includes several points of view which are still contested by some, including the ideas that there are limits to growth, and that ‘resources’, including ‘human resources’ such as education, should be distributed in a more equitable manner. Many international statements on environment and development, for instance, do not seriously challenge the principles of economic growth or even the inequitable distribution of resources (IUCN, 1980; World Commission on Environment and Development, 1987).

Nonetheless, environmental education often is regarded as a tool to turn the tide on environmental degradation. Resolving environmental issues involves addressing ethical questions, for instance, regarding the injustice in sharing the use of the world's natural resources. We do not know the answers to these questions and should not pretend that we do, but we do know that they cannot be found without also looking at issues of development, peace and conflict, and human rights (not to mention the rights of other species...). It is our assertion that we should involve people, including students, in the challenges of our time. "If the school does not develop the debate [that results from] the doubts raised by [the criticism of the] technical rationality in our way of life, then we will fail to involve [students] in the biggest political challenge of our time." (Bondergaard, 1991; p. 8). Nobody knows the right ethical lifestyle, but we all have to be responsible for seeking a world which is built upon human equality and sustainable sharing of natural resources, not only between members of the Western world, but the world as a whole.

Finally, good environmental education also enhances a critical stance towards the world and toward oneself by promoting discourse, debate and reflection (Stapp et al., 1996). It is through discourse that participants engage in a process of self-reflection on the relationship between their own guiding assumptions and interpretations and those of others. Inevitably, the process of values clarification comes into play here. Since values cannot ethically and pedagogically be imposed, environmental education is to provide situations in which all participants feel free to discuss and make explicit their values. To achieve the necessary 'communicative competence' (Habermas, 1971) requires both equal participation in discussion, minimally distorted by power relationships, and an unlimited scope for radical questioning of societal structures and procedures.

It seems that a pedagogical approach to environmental education characterized by its emancipatory component offers more possibilities in this regard. As we already pointed out this approach puts the learner at centre stage with her own meaningful interpretation and assessment of a particular situation, her own intentional acting and her own motivation to learn. The resulting involvement in the learning process can become the bedrock foundation for future actions and acting. After all, a pedagogical approach aims for carefully guided and facilitated education which allows young people to decide for themselves if, when and how to take action for the environment, based on their own critical analysis of the issues at stake.

In summary a pedagogical approach to environmental education broadly refers to all learning that enables participants to construct, transform, critique, and emancipate their world in an existential way (see also Stapp et al., 1996; Wals & Van der Leij, 1997). *Construct* in the sense of building upon prior knowledge, experiences and ideas of learners. *Critique* in the sense of investigating underlying values, assumptions, world views, morals, etc., as they are a part of the world around the learner and as they are a part of the learner him/herself. *Emancipate* in the sense of detecting, exposing and, where possible, altering power distortions

that impede communication and change. *Transform* in the sense of changing, shaping, influencing the world around them, regardless of scope or scale.

Now that we have made our biases explicit, we will focus on the issue of 'quality' in environmental education. How can we tell 'good' from 'bad' in environmental education? As always this will depend on what one finds important, what one looks for and how one assesses whether what one is looking for is actually seen.

2.3 Environmental education and ideology

"By presuming to provide a set of common guidelines, an understanding of what students should know and be able to do, and a definition of what is valued, [the leaders of NAAEE] appear to be rapidly retreating into the modernist, or deterministic, world view that so many environmental philosophers have identified as the very root of our environmental problems" (Jickling, 1995; p. 13).

Within the field of environmental education roughly three different research traditions have been distinguished: the empirical-analytical, the interpretive-hermeneutical, and the social-critical paradigm. The differences between different approaches to educational research are 'paradigmatic' in that they express, or are expressions of fundamentally different ideologies or world views. There are fundamental differences underlying empirical-analytical, interpretive-hermeneutical, and social-critical methods that imply epistemological differences (Mrazek, 1993; Robottom & Hart, 1993; Sauvé, 1996). The empirical-analytical paradigm is often referred to as being behaviourist, and the interpretive-hermeneutical, and social-critical paradigms are often referred to as non-behaviourist (Robottom, 1993). According to Robottom, the most obvious difference between the non-behaviourist and the behaviourist paradigm in environmental education is the perception of what counts as an educational theory. Whose goals are the focus of the research? In the interpretive-hermeneutical and the social-critical paradigm, the interpretive activities of practitioners are explicated; their aspirations, presuppositions, assumptions, and values can be made intelligible. In the empirical-analytical paradigm it is the researcher, or the sponsor of the research who decides what is important.

When accepting the premise that the above 'paradigms' are ideologically different, one also accepts that they are incompatible. Consequently, operating as an environmental educator within the behaviourist paradigm implies a specific view on the role of education in society, as does operating within a non-behaviourist paradigm. One could argue that the current environmental or ecological crisis is deeply rooted in a deterministic world view and its positivist and behaviourist science traditions. It is questionable, to say the least, that the same world view and science tradition is able to solve the very crisis to which it contributed. Translated to environmental education we argue that behaviourist approaches to environmental education are part of the problem and not part of

the solution. Instead, environmental education that is concerned with *human development*, rather than with *human behaviour*, could contribute to the formation of new lenses which re-examine our lifestyles, power relationships, our connection with the earth and our connection to other (human) beings in order to develop alternative pathways for living.

Turning back to the issue of evaluation in environmental education, one could argue that from a behaviourist perspective it seems logical, desirable and feasible to attempt to reach consensus among national (environmental) education experts regarding specific goals, objectives, methods, learning outcomes and the ways of measuring them. One could even design some kind of accreditation system for environmental education. For environmental education for human development the setting of *national* quality standards for environmental education is more like a contradiction in terms since human needs and interests - fortunately, perhaps - vary with context. This does not mean that there should not be any standards by which we can tell the 'good' from the 'bad', but such standards should focus on the quality of the learning process and not on some kind of learning outcome or product. It should be noted that the 'paradigm-compatibility' debate within the environmental education community, or should we say elite ..., mimics or follows a similar debate in educational research in general (i.e. Moss, 1996; Posch, 1994; Sanger, 1995).

Our critique of using positivist and behaviourist worldviews to develop environmental education can be summarised as follows (see also: Jickling, 1995; Robottom, 1993; Robottom & Hart, 1993; Stevenson, 1993; Wals, 1993):

- individual human agency is not the key factor in issue solutions; environmental issues are almost always political struggles, and therefore, collective action is more productive.
- the paradigm is limited in helping us deal with moral and ethical issues. Since it provides only scientific knowledge, curriculum change becomes a purely technical or behavioural concern, requiring that teachers implement ideas of external curriculum developers.
- the approach fails to recognise that curriculum change results from practitioners in a struggle to understand their own values, theories and intentions, and how they are played out their particular setting.
- the approach has a deterministic character: teachers and students are seen as essentially manipulable by the researchers (even if they don't want to change; this is contradictory to a democratic society with critically thinking individuals).
- there is no objective way to study human phenomena.
- there is more than one way of thinking, and knowing.

Table 2.1 highlights some differences in emphasis between 'behaviourist' and 'non-behaviourist' approaches to education.

	BEHAVIOURIST	NON-BEHAVIOURIST
Focus	Learning for knowing	Learning for being
Epistemology	Objectivist Positivistic	Subjectivist Socially/historically constructed
Knowledge generated	Propositional; linear Universal	Experiential; non-linear Contextual
Structure	Subjects Disciplines	Issues Life-world
Teacher's role	Expert Instructor	Facilitator Co-learner
Role of learner	Consumer	Creator of knowledge
Teaching strategies	Lectures on theory Modular instruction	Real world Experiential
Research Style	Experimental RDDA-model (linear; expert driven)	Participatory R *is* D-model (non-linear; practitioner driven)
Role of researcher	Producer of knowledge & solutions External expert	Co-creator of improvements Participant
Research goal	Abstract knowledge	Local theory and action for change
Power relationships (PR)	Reinforces existing PR	Challenges existing PR
Focus of reflection	What do I now KNOW?	Who am I BECOMING

Table 2.1 Some differences in emphasis between 'behaviourist' and 'non-behaviourist' approaches to education *(source: Wals and Van der Leij, 1997)*

Weston argues that environmental education tends toward closed, codified, theoretical, expert-certified systems (Weston, 1995). Nothing guarantees that deep matters, as our relation to the Earth, can be captured or codified, or formally "taught" or evaluated in any way at all. The assumption that it can be is possibly part of our general epistemological over-confidence. If we, environmental education researchers, start formulating goals and outcomes for environmental education, it is us who decide what is good for the students:
"All of these are 'lessons' in which students are required to learn to receive the necessary certifications. We are still deciding what is good for them, only now it is not American history or chemistry labs anymore, but getting back to their senses

or back in touch with the Earth. And, of course, once again, there is everything to be said for these goals. Getting back into their senses is good for them. I love the idea of students taking responsibility for their own school grounds, and so on. The problem is not with these goals. The problem is that they are our goals. They are not goals that emerge naturally out of these children's or students' own lives." (Weston, 1995, p. 6).

One of the presuppositions stated in the beginning of this contribution is that our planet is facing destruction as a result of symptomatic environmental problems, which are rooted in the unequal distribution of wealth, the uninhibited strife for economic growth, and inadequate education. If we think it is important that students think critically and autonomously about these matters and develop the necessary communicative and action competence, then it is essential - taking into account the critique on a behaviourist approach to environmental education - that we move towards process-based quality assessment of environmental education.

2.4 Components of high quality learning in environmental education

Like it or not, it is the current reality that many sponsors of environmental education, whether they are governmental or commercial, are looking for some way to assess the effect or impact of environmental education. In line with our previous arguments we would rather look for some criteria which can help teachers, students, school communities and, indeed, outsiders to assess the quality of the learning process.

Technically to evaluate means to determine whether something has value. To be able to determine whether a learning activity is valuable one would have to agree as to what is considered valuable, for whom and by whom and how is this to be expressed and assessed? The answers to these questions are to a large degree dependent on the kind of environmental education paradigm of which one is, knowingly or unknowingly, part. When extrapolating our line of thinking it follows that we should not as environmental education experts just focus on formulating the *content* and *outcome* of environmental education, but also on the elements that determine the quality of the learning *process*. The quality of the learning process determines whether a learning experience is fundamental enough to penetrate the world of the learner.

Environmental education, by its very nature, should be education that focuses on the life-world of the learner. A prerequisite is that the educator immerses him/herself in the world of the learners and the realities by which they are challenged, inspired or motivated. Only if this world is understood well enough, it can act as a base for learning. This implies that the learners themselves help determine the content of the learning process, and not in the first place the ‘curriculum expert’ or even the educator. In process-based environmental education the learner determines to a great extent the content and direction of

the learning process, while the educator, taking on the role of activator and facilitator of learning, is much more concerned with the quality of the learning process. But we are still left with two basic question: “What entails good environmental education?” and “How can the development and evaluation of environmental education become more democratic and contextual? Evaluating an activity always requires the application of predetermined criteria. With Stokking et al. (1995) we agree that one of the most important aspects of evaluation is a careful choice of criteria. We carried out several exploratory studies to develop anchor points for determining the quality of the learning process and the appropriateness of environmental education content: some focussing on learning enhancement criteria for environmental education in general (Alblas et al., 1993; Albla s et al., 1995; Wals and Alblas, 1995) and some focusing on determining suitable core themes for nature conservation education in particular (Margadant, 1996).

2.4.1 Process anchors

Explorative research at our department, carried out in conjunction with Utrecht University, led to the development of a set of so-called learning enhancement criteria for environmental education (Alblas, Broertjes, Janssen & Waarlo, 1993; Alblas, Van den Bor & Wals, 1995; Janssen, Waarlo, Alblas & Broertjes, 1994). The research focused on finding those elements of environmental education, which are particularly suitable for increasing students' understanding of environmental concepts on the one hand, and their involvement in environmental issues on the other. Five experienced teachers from secondary schools, with a strong affinity for environmental education, were interviewed extensively on several occasions about their own praxis-theories concerning environmental education. In a variety of subsequent studies these criteria were used, evaluated and modified into so-called process anchors for the evaluation and design of environmental education learning activities (Alblas et al., 1995; Alblas, in press).

Hence, the process anchors we will describe here have been derived mainly from experienced teachers' *own* theories about learning in environmental education (see also: Hart, 1996). They are intended to serve as an instrument to help improve the content and quality of learning processes in environmental education within a specific context. The anchor points are not listed in any type of order and are intended to help teachers reflect on their own teaching, to guide them through (process) evaluation and to assist them in developing new teaching materials.

1. Total immersion

Learning by doing, discovery learning, hands-on learning or experiential learning all have in common that the learner becomes immersed in a multi-sensory way in a learning process that is fundamental enough to have a lasting impact on the state of mind and being of the learner. A learning experience becomes fundamental when the whole person becomes part of the learning experience (i.e. head, hart and hands).

2. Diversity in learning styles
People are not all alike. For environmental education to become a meaningful learning experience, environmental educators will have to recognise and be sensitive to the various learning styles and preferences that can be found in a single group. It is unlikely that one particular learning and instruction technique will be appropriate for all involved in a leaning process.

3. Active participation
To become involved in something requires active participation in a dialogue with co-learners and teacher-facilitators. It is through this active participation that the learner develops a sense of ownership in the learning process, its content and its course. Through dialogue, the bouncing of and developing of ideas in a social setting, the learner can express his or her feelings or thinking and become exposed to the feelings and thinking of others. This confrontation is essential for meaningful learning to take place.

4. The value of valuing
In good environmental education the development of values and meaning coincide. The motivational and affective aspects of learning should be given equal attention. The process of valuing should at least have the following components or steps (Brugman, 1988):
1. Putting in words what is found to be important with regard to the subject at stake (explicating personal values).
2. Putting oneself in the positions taken by others with regard to the subject at stake (taking on multiple perspectives).
3. Confronting one's own personal values with those of others to recognise commonalities and differences (confronting and relating personal values).
4. Investigating and discussing the relationship between personal values and corresponding behaviour (or the lack thereof) (validation of personal values).
5. A prime objective of following these steps is to develop in the learner a system of values and valuing which is characterised by flexibility, openness and pluralistic respect (i.e. respect for well-argued alternative values).

5. Balancing the far and near
A contemporary curriculum should reflect a society, which increasingly demands the integration of environmental and other global issues. At the same time such a curriculum should be rooted in the life-world of the learner. Inevitably meeting both criteria will cause some friction. After all, issues of environment and development, for instance, are not always existentially relevant. How can we expect someone to take interest in problems that seem physically, socially and psychologically remote? Or, more specifically, how do we design learning activities that move students from passive detachment to active involvement in environmental issues without having them feel overwhelmed or powerless?

Involvement in the learning process is essential for good education. At least three dimensions of involvement and detachment can be distinguished: a personal, social and physical dimension (Table 2.2).

	Involved	De-tached
Personal	I	II
Social	III	IV
Physical	V	VI

Table 2.2 Dimensions of involvement and detachment

Cell I: Personally involved
A person is personally involved when he or she has a personal stake in becoming engaged in the learning process or its content on emotional grounds.

Cell II: Personally detached
A person is psychologically detached when he or she remains emotionally unaffected by the learning process or its contents.

Cell III: Socially involved
A person is socially involved when he or she or a group to which he or she relates is put in a socially questionable situation (i.e. unfair treatment, lack of commitment, unethical behaviour, lack of solidarity) by the learning process or its content.

Cell IV: Socially detached
A person is socially detached when he or she or a group to which he or she relates remains socially unaffected by the learning process or its content.

Cell V: Physically involved
A person becomes physically involved when the learning process or its content are considered to be part of his or her everyday life and inspires or requires personal action.

Cell VI: Physically detached
A person is physically detached when the learning process or its content are not considered to be part of his or her everyday life and does not promote personal action.

The above matrix suggests a dichotomy between involvement and detachment where a continuum would be more true to reality. All combinations are possible, but the dimensions are highly interdependent. In other words, when one dimension

leads to integral involvement in the learning process this is likely to lead to other types of involvement as well. On the same token it is likely that when one dimension leads to detachment from the learning process, this dimension will negatively influence the other two. A balance needs to be struck between the far and near of these dimensions in order for empowerment of learners to take place. Empowerment here refers to the feeling that one, albeit as an individual or as a member of a group, can shape one's own life and environment.

6. A case-study approach

Human development can be characterised by a double edged sword: with the 'objective' material conditions on the one side and the subjective personal needs on the other. Both aspects are relevant for the process and content of education. The challenge is to find exemplary cases which not just address subjective personal needs, but address the need for an understanding of more universal principles (Klafki, 1994). A case-study approach allows for the learner to dig for meaning, as opposed to scratch the surface, by focussing on one concrete example for a longer period of time. Taking sufficient time to study a particular issue in-depth is essential and is preferred over studying multiple issues in a superficial way. The teacher needs to take an active role in stimulating learners to expand their boundaries of understanding by challenging them to look further and exposing them to alternative ways of looking at the same issue.

7. The social dimension of learning

The development of knowledge and understanding has both personal and shared elements to it. Social interaction allows one to relate or mirror his or her ideas, insights, experiences and feelings to those of others. In this process of 'relating to' or 'mirroring' (Cassel & Giddens, 1993), these personal ideas, insights, experiences and feelings are likely to change as a result. This mirroring may lead the learner to rethink his or her ideas in light of alternative, possibly contesting, viewpoints or ways of thinking and feeling. At the same time (learning) experiences, which are shared with others, are likely to gain importance. Which is not to say that personal experiences, which are kept to oneself, are insignificant. But shared viewpoints or ways of thinking and feeling give the learner a sense of competence and belonging to the community of learners.

8. Learning for action

The argument for including action-taking and the development of action competence in environmental education programmes is threefold. First, one could argue that many young people, as is the case with many adults, are overwhelmed by environmental, including social, problems as a result of their personal exposure to these problems in real-life, for instance, through the ever present media. It is important to help learners explore environmental issues and to provide them with an understanding of the nature and the complexity of these problems. However, environmental education should not be limited to this for it then could easily feed feelings of apathy and powerlessness. It would be dangerous if environmental education would become a repetition of what many of us already know: the

environment is in a bad shape, our comfortable lifestyles make it worse and the complexity of environmental issues makes them hard to solve (Monroe, 1990). By bringing in the action-taking component students can, under certain conditions, begin to take charge of some of these issues and develop a sense of power and control.

A second argument for including action-taking in an environmental education project has its roots in experiential learning thought: one never comes to fully understand a problem with all its nuances and complexities until one fully immerses oneself into the problem, identifies all the players and begins to work within the 'force field' or field of interference's towards a joint solution (Wals, 1994b). On the same token one could say that we may never really understand the problem until we start to actually implement some potential solutions.

Finally, it could be argued that without the ability and willingness to act it is impossible to participate in or, rather, to contribute to a democratic society. As Jensen and Schnack (1994) point out a concern for the environment should be connected to a concern for democracy.

It should be noted that good environmental education does not have to include *all* the process anchors listed in Table 2.3 on the next page. In all likelihood a subset will have to be considered depending on the context (i.e. age of the learners, formal or non-formal education setting, time available, etc.) and purpose of the learning process.

The process anchors or learning enhancement criteria - which by no means are carved in stone - are valued most by teachers who themselves developed teaching modules (Wals and Alblas, 1997). Firstly, they can relate to many of them intuitively or from personal experience. Teachers who are asked to generate their own criteria for 'good' (environmental) education, usually come up with a subset of almost identical anchor points. Secondly, the process anchors enable them to look more critically and systematically at their own teaching and teaching materials which allows them to identify strengths and weaknesses. Finally, the anchors make them rethink the relationship between learning objectives, learning content and learning process (i.e. the criterion of problem-based learning cannot be met by a lecture). The process anchors also help in determining whether a particular content area or theme is suitable for generating a high quality learning process or what it would take, in terms of learning and instruction techniques, to make the theme suitable.

Principle	**Description**	**Examples**
1. Total immersion	Fostering a direct experience with a real-world environmental phenomenon	• Observing and monitoring of a natural area • Taking care of a specific site

2. Diversity in learning styles	Being sensitive to the variety of learning styles and preferences that can be found in a single group	• Offering a variety of didactic approaches • Reflecting on the learning process with the learner
3. Active participation	Developing discourse and ownership by utilising the learners' knowledge and ideas	• Soliciting the learners' own ideas, conceptions and feelings • Consulting learners on the content of the learning process
4. The value of valuing	Exposing the learner to alternative ways of knowing and valuing through self-confrontation	• Giving learners opportunities to express their own values • Creating a safe and open learning environment
5. Balancing the far and near	Developing empowerment by showing that remote issues have local expressions which one can influence.	• Relating issues of biodiversity or sustainability to tonight's dinner • Showing examples of groups of people successfully impacting the local and global environment
6. A case-study approach	Digging for meaning by studying an issue in-depth and looking for transferability to other areas	• Assigning different people to explore different angles of a particular theme and bringing the different angles together
7. Social dimensions of learning	Mirroring the learner's ideas, experiences and feelings with those of others through social interaction	• Taking time for discussion and exchange • Taking on controversy • Stimulating flexibility and open-mindedness
8. Learning for action	Making the development of action and action competence an integral part of the learning process	• Allowing learners to develop their own course of action and to follow through • Studying examples of action taking elsewhere

Table 2.3 An example of process anchors for evaluation

2.4.2 Content anchors

Emphasising the quality of the learning process and creating the right conditions for learning, does not mean that there is no content. Well chosen themes for learning enhance the quality of the learning process (Margadant, 1996). One of the

problems in environmental education is that the objectives, content and teaching and learning strategies used are not described with sufficient clarity. In other words: what environmental education aims to do is still vague and open to many interpretations, not only to outsiders looking in, but also to veteran insiders. The choices made with regard to content are made fairly arbitrary without supporting arguments.

Frustrated by this lack of clarity and consistency, the Dutch Ministry of Agriculture, Nature Management and Fisheries initiated a study of the types of educational goals as distinguished and emphasised by key environmental education resource persons in the Netherlands (Margadant, 1996). The Ministry was particularly interested in educational goals, which focused on nature conservation. Based on the study an attempt was made to generate, among other things, a well-argumented prioritisation of educational goals and a careful selection of learning themes. For a detailed outline of the study see Margadant (1996). Apart from some differences in emphasis and in nuance, a surprising consensus emerged from the interviews, which is possibly the result of the pre-determined emphasis on nature conservation aspects.

Key concepts and themes
Nearly all the interviewees gave ecology or "How does nature work?" the highest priority teaching goal. The argument being that many people do not understand the most basic ecological principles (such as natural cycles and the relationships between organisms and their environment). The interviewees identified the concepts of: natural cycles, energy (the sun as a source/driving force of natural cycles), relationships (between organisms including human beings and the biotic-abiotic relationships), change and limits (waste, depletion, pollution and destruction), as central to this ecological foundation.

Various interviewees have linked key concepts of ecology to different meanings of nature and environmental issues. Exploring meanings of nature and environmental issues emerged as the second priority teaching goal. "Nature as a (re)source" (food, health, raw materials) and "nature and technology" were regarded as the most important key concepts of this teaching goal. The notion of "nature as a (waste) pit" was added to “nature as a (re)source” to emphasise the cyclical nature of ecological processes and the intricate relationship between nature and environmental issues. Furthermore the participants in the study regarded discussion of the relationship between nature and technology to be crucial. Such discussion would need to include the effects of production and mobility on nature and environmental issues, as well as a discussion of the technology developed to prevent and restore damage to nature, and to the environment more in general. The realisation that many technologies are derived from nature (natura artis magistra) was also regarded as important.

During the interview procedure ethical and aesthetic values were initially rejected as not belonging to the core concerns of environmental education. This subject

was raised in a follow-up discussion meeting. As a result of this, ethical values (particularly the intrinsic values of nature) and aesthetic values (beauty, delight, the wind in your hair, etc.) were emphatically added to "meanings of nature and the environment".

The educational objectives relating to "knowledge and significant meanings of society" led to the most disagreement. The majority of the participants maintained that knowledge of society should be developed as part of the development of action and action competence. Others emphasised attention to lifestyles and the importance of getting to know the people with whom you are working. Both groups seem to suggest that from an environmental education perspective an ecological and ethical foundation rings hollow when a translation to some form of action is missing.

Democratic decision-making was regarded as being of essential importance to environmental education. How are decisions arrived at and what influence can you as an individual or group have on decision-making? Study of the interaction between humans and their environment too was considered an essential part of the goal area of "Knowledge and significant meanings of the society".

What the study illustrated is that even though the contextual development of environmental education will allow for very specific local themes and objectives to emerge, there still is some general consensus at a higher abstraction level. The goal areas that emerge can become beacons or anchor points for *deciding on content*, just like the learning enhancement criteria can become anchor points for *presenting content* in an educationally sound way. Of course, the above represents one example of setting goal areas for environmental education, specifically from a nature conservation perspective. Within the spectrum of goal areas that emerged from the study we only looked at goals focusing on knowledge and insight or key concepts, leaving out the areas covering pedagogical aspects and skill development (which in part have already been covered under the section on process anchors).

Table 2.4 shows the key concepts that have been identified by the participants in the study and an example of corresponding key themes as identified by the participants for environmental education centres.

A. Key concepts
1. *Ecology - "How does nature work"?*
• Natural cycles, energy (the sun as a source and driving force of natural cycles), relationships (between organisms, including human beings and the biotic-abiotic relationships), change and limits (waste, depletion, pollution and destruction).

2. *Different meanings of nature and the environment*

- Nature as a source (food, health, raw materials), nature as a (waste) pit, nature and technology, ethical (intrinsic value) and aesthetic values (beauty, delight, etc.).

3. *Knowledge and significant meanings of society*

- Lifestyles (opportunities for action as regards one's own environment, consumption, transport, production), decision-making (in a democracy), interaction (between people and their environment).

B. Key themes

Does gone really mean gone? A theme about natural cycles, energy, change and limits

Content examples:

- What happens to the leaves that fall off the trees?
- What happens to the rain puddles in the school playground?
- What happens to the water that runs down the sink?
- What happens to waste?

The school environment or living in and around the school

Content examples:

- Possibilities for plants and animals to live.
- Possibilities for human beings (playing, socialising, exploring).
- Architectural styles, street patterns, traffic and transport.
- Caring for nature and the environment (at school and outside).

The surrounding landscape, for example 'Life along the river', a biological and cultural unity

Content examples:

- The biology or ecology of the river.
- The river as a traffic route (transport).
- The cultural development in the region (habitation, industry).
- Water management (floods).

What are we eating today?

Content examples:

What do we eat? (To be expanded to all the people in the world).

- Food production.
- Food chains.
- Meat production in the Netherlands - consequences for third world countries.
- Animal-friendly production.
- Health.

Where do jeans come from? The global dimension of everyday life

Content examples:

- Cotton plantations.
- Vegetable and synthetic dyes (indigo).
- Ready-made clothing industry (in low wage countries).
- Transport.

Table 2.4. An example of content anchors for evaluation

Of course, the question can be raised whether this notion of setting content anchors ahead of time on the basis of expert consultations is in contradiction with the idea of having learners themselves develop a sense of ownership and a stake in the learning process by allowing them to shape its course and direction. Indeed it

would be if these themes were transferred on to the learner without any room for discussion, negotiation or choice. This is where we immediately see that separating content, process and goals of environmental education is impossible and undesirable. Only in combination with the process anchors provided earlier (Table 2.3) - which, in fact, already overlap somewhat - it is possible to understand and justify the use of the content anchors in Table 2.4. Again we should emphasise that Table 2.4. was developed from a nature conservation education perspective. Had we taken another perspective, for instance, a LA21-perspective, the table would have looked somewhat differently.

2.5 Conclusions

Research has shown repeatedly that in real life situations people learn in non-linear ways and that there is no linear connection between change in 'attitudes', 'values' and 'awareness' and 'behavioural change'. It is hard to 'prove' whether an environmental education programme exclusively can be credited with impacting someone's behaviour at some point in someone's life. Should the value of an environmental education programme or activity be determined by the degree of success in changing learner behaviour, then it will be hard to find any value. The challenge will then become a methodological one of setting dependent and independent variables, using the right controls, establishing correlations, and using the 'right' behaviour schemes or models. If so-called experts get together and determine how to define and measure such a concept and how to create 'intervention strategies' to promote this concept, then the difference with Skinner's S-R models may only be gradual and we are dealing with environmental conditioning or training but not with education. We have argued that this would be contradictory to the whole idea of environmental education: the prescription of a particular outlook or behavioural outcome conflicts with the development of autonomous thinking.

It may be more rewarding to explore non-behaviourist approaches and to look at criteria environmental educators can use to improve the quality of environmental learning from an environmental *education* perspective, as opposed to from an environmental *behaviour* perspective. The question should not so much be: 'What learners should know and be able to do?', but rather 'How can we create the right conditions for learning to take place?' and 'What comprises a high quality learning process?' The anchor points we presented represent just one avenue we could explore to find ways to assess the quality of the learning process and its content. They focus mostly on realising involvement in the learning process and the constructing of knowledge (the constructive dimension identified of environmental education earlier). Perhaps we can also generate similar anchor points for the 'transformative', 'critical' and 'emancipatory' aspect of environmental education, by using teachers' and students' own ideas about good environmental education, and by analysing the few examples that exist world-wide of environmental education that do include all four dimensions.

When developing learning activities about an emerging concept like biodiversity, curriculum development teams will have to find ways to meet the process and content criteria outlined in this chapter. When guided by a pedagogical framework, they will also be inclined to leave sufficient room for learners to jointly construct their own meanings of biodiversity and to explore their own pathways to sustainable living. This does place a heavy responsibility on the facilitator of the learning process who will have to guide the learners through an arena of conflicting norms, values, knowledge claims and ways of looking at the world. But it is exactly the wise navigation of those conflicts and disputes and the wise use of expertise and (local) knowledge in an attempt to find one's own niche for action-taking, that sets environmental education apart from science education on the one hand, and training for good citizenship on the other.

3 BIODIVERSITY AS A THEME FOR ENVIRONMENTAL EDUCATION[1]

By Amos Dreyfus, Arjen E.J. Wals and Daan van Weelie

3.1 Introduction

Contemporary environmental education will have to be sensitive to the ill-defined nature of key emerging concepts such as biodiversity and sustainability. Despite all the confusion about such concepts, one thing is clear: there is no one single way of looking at them or defining them. In other words, there is no one single perspective or definition of biodiversity or sustainability that accurately describes them in all situations or contexts. Although this "ill-definedness" renders such concepts useless or reduces them to a rhetorical instrument from a modernist point of view, it makes them attractive from a postmodernist perspective. When acknowledging the need for respect for pluralism (respect for different ways of looking, valuing, understanding, etc.), the ever presence of elements of ambivalence and uncertainty in environmental decision-making and the need for learning situated in a rich context, environmental educators will find merit in the ill-defined nature of these emerging concepts. Using biodiversity as an example the we will illustrate the educational appeal of ill-definedness.

Biodiversity brings together different groups in society in search for a common language to discuss nature conservation issues in relation to sustainability issues. The mere fact that these groups, with diverging backgrounds, focus on a common concept – even though what the concept means to each group varies – allows for, what we will refer to as, a socio-scientific dispute to emerge. This socio-scientific dispute provides an excellent opportunity for learning about a highly relevant, controversial, emotionally charged and debatable topic at the crossroads of science, technology and society. Special attention is given to the role of scientific knowledge in such disputes. This attention is not to suggest an emphasis on rationality, scientific and environmental literacy and cognitive development in learning about biodiversity, at the expense of, for instance, the emotional and political dimensions of such learning. On the contrary as has been argued in the previous chapter and as will be argued in the next chapter, these dimensions are crucial as well. Here we emphasise the role of scientific knowledge and socio-scientific disputes to provide yet another justification – one that tends to be ignored by postmodern environmental educators – for teaching and learning about biodiversity.

[1] This chapter can also be found, albeit in a slightly different form, in Volume 4 (1999) of the *Canadian Journal of Environmental Education*.

3.2 Biodiversity as a concept for environmental education

The concept of biodiversity is receiving world-wide attention, most notably among scientists and politicians but also among environmental educators. In part this attention is a result of attempts by many national governments to translate the 1992 Convention on Biological Diversity into concrete measures and actions. The convention encourages and commits countries to act on the promise to protect biodiversity by using a variety of means, i.e. policy instruments, education, communication and research. The convention emphasises conservation in relation to issues of equity and sustainable use, thereby pulling people from diverging backgrounds into the debate.

A distinction can be made between political or more symbolical definitions of biodiversity on the one hand and scientific definitions of biodiversity on the other. The symbol of biodiversity refers to the environmental problem of the decreasing variation of life and to the normative demand that we *should* do something about it. But for biodiversity to be a symbolic concept there need not be anything 'out there' one could identify and name 'biodiversity'. In other words, as a symbolic concept biodiversity has no empirical reference. In order to know exactly *what* is lost, and *what* should be done to stop 'biodiversity' losses, scientific concepts or concepts referring to the variety of life with empirical reference, are essential. Such concepts refer to entities -phenomena out there - that can be identified and, indeed, somehow measured. One question we should pose as environmental educators is: How to deal with this continuum of meanings that exists between political uses and meanings of biodiversity on the one hand and scientific uses and meanings on the other?

Results of a two-year study carried out in the Netherlands (Van Weelie & Wals, 1998; Wals & Van Weelie, 1998) indicate that biodiversity is an ill-defined concept. This ill-definedness can be characterised by the following features:

- tendency of being inclusive rather than exclusive (or hard to narrow down)
- can be interpreted in many different ways
- value-laden or normative
- hard to give meaning in a specific context

This ill-definedness is not necessarily a weakness from a postmodern environmental education perspective. Learners are confronted with many concepts in every-day life that share this characteristic with biodiversity. Think, for instance, of sustainable use, sustainability or sustainable development. Recognising the different political, symbolic and scientific uses of such concepts and making a critical assessment of their strengths and weaknesses could be an important learning objective in environmental education. Exploring the different meanings, values and uses of biodiversity could easily become a vehicle for developing critical thinking skills and respect for different ways of looking at the world.

Conceptual ill-definedness appears to be a phenomenon that is well worth paying attention to in postmodern environmental education, especially when a) ill-definedness is seen as an opportunity to give a concept personal (or local or contextual) meaning, and when b) learners become aware of the ill-definedness that lies behind popular concepts that appear to be clearly defined on the surface. Let us dig a little deeper in the pluralism of concepts and meanings of biodiversity and their implications for environmental education.

An educationally important assumption is that everyone has some intuitive perception of the meaning of biodiversity. Everyone essentially "knows" what biodiversity is and recognises biodiversity everywhere. Everyone's experience shows there are lots of living beings in the world that are very different from each other, at all levels, so that there is a tremendous biodiversity. There is nothing wrong with this description. Educators who wish to base the learning about biodiversity on people's existing knowledge have a good starting point. Even young children may have a good intuitive grasp of some scientific notions, such as that of species (a cat is not an elephant, and a rose is not a tulip).

The same educators would attempt to lead people towards the construction of a less naive definition, by means of identifying the attributes of *the* concept of biodiversity. And they would find the task to be impossible. As stated by many authors, biodiversity eludes definition (see for example Magurran, 1988; Wood 1997). There is apparently no universally agreed upon definition of biodiversity, in spite of the enormous use of the term in the scientific literature (Harper & Hawksworth, 1995). Takacs (1996; p. 46) obtained from scientists only very broad definitions like "the sum of the earth species including all their interactions and variations within their biotic and abiotic environment in both space and time." Erwin told Takacs in an interview: "You are talking about a subject which is literally as large as the world itself." But such broad definitions of biodiversity mean different things to different people. Or, in the words of Van der Maarel, "People from diverse backgrounds talk about biodiversity.... [they have] all absorbed the term biodiversity and fitted it into their own jargon" (Van der Maarel, 1997; p.3). Magurran (1988) gives an overview of the different emphases a biological scientist can use in studying aspects of biodiversity (genetic, species, guilds, habitat, ecosystem, landscape diversity, with subdivisions). In a similar way, based on Salwasser's (1991) focal elements for the conservation of biodiversity through ecosystem management, Takacs (1996) shows how "ecosystem" may represent different things to different biologists. At this point we have not even entered terms used in the Rio-convention which blur the picture even more: equitable distribution, sustainable use… Takacs in the end concludes that biodiversity is an intentional construct developed by a particular group of people at a particular time which means what its creators say it means. Its normative commitments are entailed in biodiversity as defined by its creators.

As suggested earlier this situation leads to the impression that biodiversity is an ill-defined or fuzzy concept. The term should be clarified further to avoid questiona-

ble educational implications. We should first note that a concept is a class of elements, concrete or abstract -objects, events, ideas, symbols - grouped together according to some shared characteristics, attributes or dimensions. A concept described as "ill-defined" may be perceived as one of which the attributes are fuzzy, not well defined or used in a loose way. This is not necessarily the case with biodiversity. Consider the term as used in the Magurran definition, or all the attributes of biodiversity suggested in Wood's (1997) references to various reviews: richness, evenness, equability, frequency, number of entities in a standard sample, composition, structure, function, ecological processes, cladistic hierarchies, phyla-genetic lineage, etc. Or, consider McNeely et al.'s definition (1990, also quoted by Wood, 1997; p. 252): "Biodiversity encompasses all species of plants, animals, and micro-organisms and the ecosystems and ecological processes of which they are part ...number and frequency of ecosystems, species or genes ...three levels: genetic diversity, species diversity, and ecosystem diversity". There is nothing fuzzy in the use of those terms by scientists. Their use involves the stipulation of careful definitions. Although it can be argued that even the careful stipulation of definitions and their concepts also involves social construction and it therefore subject to interpretation and disagreement.

Mathematical and scientific concepts are generally regarded as "well-defined" in the sense that their attributes or dimensions are well defined, and that they can be transferred across situations or contexts without changes in their definitions (e.g. Tennyson, 1996). Ill-defined concepts on the other hand are more culture bound, and they have characteristics that vary with the context or situation in which they are used. The latter definition is closer to the view of biodiversity as perceived by many authors. The concept varies with the approach of the scientist. It is not the attributes or the dimensions that are badly defined. Instead it is the approaches which are different, thus bringing about *different selections of relatively well-defined attributes*. In fact, the overall picture of biodiversity, when studied by different scientists, has been carved into different, most of them equally legitimate, puzzles. All the pieces of the different puzzles cannot be used simultaneously, although each piece tends to fit one of the puzzles better.

Implications for education

"The main difficulty in defining biodiversity," suggests Wood (1997; p. 252-253), "is its *multi-dimensional* character, along with the fact that the dimensions are not commensurable; they cannot be reduced to a single statistic." Biodiversity appears not to be one ill-defined concept, but a number of neighbouring concepts, under the umbrella of a common term. With such a view in mind, the task of the environmental educators is quite clear: *to teach meaningfully a concept that cannot be reduced to one idea and the dimensions of which cannot be reduced to one common statistic*. Such an approach to the educational task means that the basic concepts that make up a kind of core of biodiversity must be taught, and put in the context of various approaches, so as to make them *functional*. By "functional," we mean that people recognise when a concept makes a difference. In other words, when people realise that a different comprehension of a particular

concept would lead to different conclusions or implications, and when they realise that the use of the concept is irrelevant or out of context (Dreyfus & Jungwirth, 1989).

This implies that people have some understanding of the scientific and technological concepts that may allow them to assess the implications of *human technological interventions in nature* and the validity of suggested solutions, according to various views. It also means that the various views of biodiversity, conservation and related goals and objectives (e.g., endangered species, habitat, ecosystem integrity, process of evolution, social and environmental equity, etc.) should be presented. Only then would people would have true opportunities to make their own judgements --as enlightened citizens in a democratic country-- concerning the importance of biodiversity, the reality or validity of claims concerning damage to biodiversity, and the implications of such damage. Educating *for* a particular end, in such a view, does not mean partisan indoctrination, but the development of the knowledge, and the intellectual skills and flexibility which make people able to appreciate diverse approaches to science- and technology-laden social problems. The latter is sometimes referred to as the development of respect for pluralism (Brennan, 1992; Firth, 1995). It means developing the level of ambivalence (Gardner, 1987; Dreyfus & Roth, 1991), and the ability to appreciate opposing arguments, necessary for a sound appreciation of complex problems, and at the same time, developing the ability to work towards consensus and make decisions concerning priorities and action.

3.3 Values of biodiversity

…Conservation biologists as objective discoverers and portrayers of the truth of the biodiversity crisis are fictional beings - they are no more privileged presenters of "facts" than are scientists at the Tobacco Institute or lobbyists for Handgun Control, Inc. (Burnett, 1998).

It would be beyond the scope of this discussion to review the numerous instrumental, homocentric values that different authors have attributed to biodiversity: scientific, ecological, economic, cultural, aesthetic, etc. All these approaches focus on biodiversity as a biological resource for the well-being and survival of humankind, a resource that must be conserved or preserved. The approaches do not, however, focus on the value of diversity itself. The weakness of these views (Ehrenfeld, 1988; Wood, 1997) is that such a resource may be "traded off" for the very development projects which deplete biodiversity, i.e., for allegedly more useful or more immediate resources. As McPherson, quoted by Wood (1997) points out, people have competing interests, and "no single group ... has proposed a group of reasons which are sufficiently compelling and appealing to generate the necessary support to ensure that all of the biological diversity they value be maintained."

Wood (1997; pp. 255-257) classifies these arguments into three main types. Biological entities are valuable as:

1. resources: the biological materials which are consumed or exchanged in markets, or the organisms and ecosystems which are valued for their recreational, cultural, or aesthetic purposes;
2. potential resources, i.e., "opportunities for the discovery of new and valuable resources" (e.g., knowledge, materials, genetic resources); and
3. contributory factors, "in the sense that they contribute to the functioning of healthy ecosystems, which in turn produce organisms and services ...."

People should be made thoroughly aware of the strengths and weaknesses of these types of arguments. However, in view of the environmental crisis and of the human-induced rate of species extinction (Ehrlich & Wilson, 1991), they should also be made aware of a more abstract type of argument, which attempts to show the *instrumental* value of diversity itself. And the understanding of this type of argumentation requires some sound scientific literacy.

These arguments refer to the danger of reducing biodiversity itself. Wood (1997) sums up this type of argument in the following way: 'current biological resources are vulnerable to insect and disease pests, to adverse climatic conditions, etc., because they lack genetic diversity. An abundant supply of wild genetic resources is required to prevent the depletion of current resources, which are essential if the exploding human population is to survive. For many reasons, biotechnology is unable to supply the necessary diversity of genetic resources (Baumann et al., 1996) or has disadvantages that may ultimately outweigh its possibilities (e.g. Westra, 1998; Mannion, 1995). Nature continues to change in non-predictable patterns, and some of these changes may be human-induced (i.e. depletion of the ozone layer, global warming, etc.). Humans are vitally reliant on nature's ability to adapt, and biodiversity is a precondition for adaptive evolution. Humans are therefore in a state of "obligatory dependency on biodiversity." For various reasons, biodiversity appears to "beget biodiversity" and is a necessary precondition for the self-augmenting maintenance of itself. Biodiversity is therefore a necessary precondition for the availability of biological resources, and cannot be traded off. This appears to be its quintessential value. And the conclusion is relatively abstract: any "resource" may be traded off by any society, to fulfil its socio-economic interests, or its survival needs, *provided that biodiversity is not depleted* (Wood, 1997*)*.

As both Takacs and Wood notice, the ecological argument, which assigns an inherent instrumental value to biodiversity itself, has its detractors. Nevertheless, when recognising the acute potential danger to humankind or when paying attention to Wilson's (1992) "one planet, one experiment" warning, it is conceivable that citizens should be provided with the opportunity and the tools to appreciate Wilson's question: If enough species are extinguished, will the ecosystem collapse, and will the extinction of most other species follow soon afterwards? After all, by the time we find out, it might be too late.

Implications for education
The tools necessary to develop knowledgeable and somewhat rational opinions, concerning this issue, and to develop relevant empowering skills, can come only from a thorough "biodiversity education." The argument may appear to be somewhat circular: if nature is biodiversity, then claiming a priori that nature must be taken care of, is equivalent to claiming that biodiversity must be conserved. But the educational argument is slightly different: in a democratic society, the defence of biodiversity requires literate, and even ambivalent, citizens who understand the various dimensions of biodiversity. Citizens have to be able to grasp the contradicting claims concerning the central importance of biodiversity and understand the ways human activity and technology influence biodiversity. From the point of view of both education and democracy, it is more appropriate to help citizens become well informed, critical and competent than to help them become well intentioned, but ignorant and fanatic.

The discussion has been based intentionally on the unlikely extreme case in which people reject the intrinsic values of nature or of biodiversity. This is not necessarily true. However, without underestimating the possible validity of such intrinsic moral values, and without neglecting or rejecting them a priori, most environmental educators would not consider them to be convincing enough as a basis for environmental education, and would search for more human-oriented grounds. As basically "non-behaviourist" educators, they would not ignore the "socio-scientific dispute" character of biodiversity, and as result, recognise the need for scientifically, technologically and socially, *literate* students.

3.4 Science, literacy and socio-scientific disputes

Scientific and technological knowledge has always been recognised as a basic component of environmental education and environmental literacy (see for instance the report of the Tiblisi conference, UNESCO, 1978; Hungerford, Peyton & Wilke, 1980, but also, Huckle, 1991). However, *scientific knowledge* is referred to mainly as a source of well-established *information* to be used in discussions, experiments, decision making processes, etc. In spite of Rubba and Wiesenmayer's (1988) claims or recommendations, "foundational competencies," such as the understanding of the nature of science, scientific laws and explanations, and of the power and limitations of science, are rarely overtly treated in environmental education materials. A scientifically literate person, according to Bybee (1991a, b), understands, among other things, the nature of modern science and modern technology, the nature of scientific explanation and of technological solutions to human problems, and the limitations and possibilities of science and technology. Miller (1990) made an important distinction, especially from the point of view of environmental education, between "learned" people, who possess knowledge, and "literate" people, who are able "to read about, comprehend, and express opinions

on scientific matters." In order to express an opinion" a *minimal level* of scientific knowledge is thought to be required, buttressed by a suitably positive attitude *towards science and scientists* (emphasis added; Solomon, 1990, p. 107)." Ramsey (1993, p. 243) believes empowerment involves "knowledge and processes of both science and democracy." Bingle and Gaskell (1994, p. 186) suggest that scientific literacy's main component is the ability to make decisions and solve problems where science, technology and society interface."

We have tried to show that biodiversity is both a descriptive and normative term. Let us briefly compare biodiversity with another ambivalent phenomenon that shares similar qualities: health. It can be argued that conservation biologists can and should prescribe personal and public actions. However, this analogy fails for two reasons, according to Burnett (1998). First, the knowledge and understanding of biodiversity and all its interacting components is in its infancy relative to medicine's understanding of the standards and threats facing human health. Second, "…even if the knowledge bases were comparable, neither medical practitioners nor conservation biologists have any particular insight into or authority concerning what decisions citizens and public officials – who must balance competing concerns and make collective trade-offs – ought to make" (Burnett, 1998, p. 205). Here the socio-scientific dispute character of such concepts surfaces again, and it is time to explore this characteristic further.

Let us first consider Huckle's formulation (Huckle, 1991) of the technological component in his inventory of goals of environmental education: it "should consider the development of technology in different societies and its impact on environment..." Referring for a moment to biodiversity and to Western students studying the impact of technology in the Western world, we obtain "the development of Western technology and its impact on biodiversity." In other words, people could benefit from an understanding of the impact of a science-based technology on biodiversity. But the impact on *what* biodiversity? The answer, depending on the type of approach to biodiversity, is extremely science-laden. After all, *biologists* are proposing various approaches that people, as suggested earlier, must understand. Firstly, people must understand *what impacts what* and *in what way*? These are very science-laden questions. At the same time they must also be able to understand possible answers to a no less science-laden and no less crucial additional question: *why does it matter?* The term science-laden does not, by any means, suggest that the answer is *exclusively* scientific, but that it has an important scientific component that can neither be ignored nor underestimated.

Secondly, because of the nature of scientific knowledge, people must understand its role in the socio-scientific dispute. This objective goes far beyond Huckle's formulation or that of the Independent Commission on Environmental Education (ICEE, 1997, pp. 2-3): "The field should place its emphasis on building environmental knowledge... Environmental educators should place primary emphasis on the acquisition of knowledge." However, it meets to some extent the Independent

Commission on Environmental Education's claims that environmental educators often mix science, or education, with advocacy.

An environmentally literate citizen should be scientifically literate enough to understand the contributions of science and technology to the creation and the solution of human problems and, vice versa, the influence of human problems on science and technology. Let us return now to the term "socio-scientific dispute." Having decided to teach biodiversity, one cannot escape the feeling that its "socio-scientific dispute" character represents a golden opportunity to educate literate and enlightened citizens. According to Bingle and Gaskell (1994, p. 187), a socio-scientific dispute is born when uncertain knowledge associated with science-in-the-making inhibits consensus as to the scientific facts. In such instances, citizens find themselves facing divided expertise - qualified scientific experts who have produced different scientific findings on an issue or who disagree over the interpretation of the same findings.

A socio-scientific dispute can even arise in the face of scientific consensus. Such a dispute arises when the consensus is challenged from the outside. This is the case, for instance, when the personal experience of citizens is in conflict with "scientific" evidence; when citizens feel that certain scientific knowledge is so new that any consensus on its factual nature must be considered tentative at best; or when certain interests are seen as having undue influence on the consensus position (Bingle & Gaskell, 1994, p. 188). Socio-scientific disputes are issues about which decision making is most problematic. They are in fact a main topic of environmental education since they are truly at the interface between science and society. They also represent a common situation, since where there is no dispute, there is no longer any issue at stake and there is only an accepted or an imposed solution.

The topic of biodiversity - when considered to be a classical, crucial, contemporary socio-scientific dispute that is potentially relevant to every person's personal or social environment - indeed represents a golden opportunity to educate and empower citizens. Teaching about biodiversity without its socio-scientific dispute aspect would be tantamount to indoctrination about desirable behaviours as well as to presenting hypothetical scientific knowledge or claims as certain. All this being said, it is clear that the role of scientific knowledge in socio-scientific disputes cannot be trivialised or underestimated.

3.5 The role of scientific knowledge in socio-scientific disputes

We will not discuss here the relativity and the tentative character of even well-established knowledge, and the influence of reality on the formation of knowledge. For the purposes of environmental education, we will accept, along with Driver and her colleagues (Driver et al., 1994), Harre's (1986) idea that scientific knowledge is constrained by how the world is, and that scientific

progress has an empirical basis, even though it is socially constructed and validated. We too will adopt the view that once such knowledge has been constructed and agreed upon within the scientific community, it becomes, for all practical purposes, part of the accepted way of seeing things within that community.

This *accepted* knowledge is the first type of knowledge that an environmental education programme must address. The *ready-made science* knowledge (Bingle & Gaskell, 1994, based on Latour and Woolgar's (1979) approach) is knowledge that is taken for granted in the scientific community, and is seen, at least temporarily, as *uncontroversial and unrelated* to the specific contexts of its development. In the context of environmental education this knowledge essentially consists of basic scientific concepts, such as principles of ecology, reproduction, etc., or basic technological understandings, in as much as they are necessary. It should be noted, however, that (environmental) science faculties around the world are increasingly becoming engaged in the discussion of what basic scientific knowledge is, in other words, in postmodern science even the foundations of ready-made science are being challenged.

What we can say now is that learning about the topic of biodiversity should at least lead people into areas of disagreement between specialists, i.e. disagreement about the perceptions of the dimensions of biodiversity, its meaning, the impact of technology on biodiversity and the hypothesised implications of such impact. This is the area of *science-in-the-making*, in which "statements about scientific knowledge are seen as *claims:* they are contestable and subject to revision" (Bingle & Gaskell, 1994, p. 187). Concerning biodiversity, as explained above, it is not a question of fuzzy or badly defined basic principles, it stems rather from different interpretations and approaches. Although based on sound knowledge and thinking, claims are sometimes largely unverifiable because of questions of time and space, and because of the difficulties in designing experiments to test them. It is of great importance that people become aware of the socio-scientific dispute character of science-in-the-making, i.e. of the development of theories, their powerful impact, as well as their limitations. Only then can people understand the relation between the nature of scientific knowledge and the role it may play in making decisions concerning socio-human problems. Such an education is indispensable for the development of literacy and empowerment.

The claim that knowledge is socially constructed - which in itself represents a dispute among social scientists - has important implications for strategies of teaching and learning, which we will not discuss here. However, it must be stressed that the notion of socio-scientific disputes arising when personal experience is in conflict with the "scientific evidence," has immediate conceptual and pedagogical implications. Scientific entities and ideas are not direct representations of reality. They are socially constructed conceptions of reality, and as such, are unlikely to be discovered spontaneously by individuals (Driver et al., 1994). Individuals' conceptions of biodiversity-related entities and processes

are generally quite different from the scientific conceptions. According to constructivist views, the resulting cognitive conflicts are at the basis of one of the main channels of meaningful learning, and of the people's *initiation into scientific ways of knowing* (Driver et al., 1994).

A sound grasping of the uncertain, hypothetical character of the "science-in-the-making" knowledge has important implications for public decision making. As Bingle and Gaskell say, a socio-scientific dispute may arise when citizens feel that scientific knowledge is so new, "that any consensus on its factual nature must be considered tentative at best." Accordingly, great prudence is advisable when making crucial decisions based on such "truths." This is exactly Takac's argument (1996, p. 202) when he suggests that the claim that diminished biodiversity means diminished prospects for human survival is "not necessarily untrue, [but] why not err on the side of caution?" However, such a feeling is valid only when it comes from a scientifically literate citizen, not from a scientifically ignorant one.

3.5.1 Implications for education

Clearly, sound, relevant scientific knowledge must be acquired through environmental education, not only as a basis of information, but as a part of people's understanding of:

- the social construction of scientific knowledge - especially in the case of an abstract, complex definition of biodiversity, and
- the role and position of scientists and scientific knowledge in public decision making and, as a result, why it has become a part of their environmental education.

This does not mean that environmental education in schools, for instance, is open only to students of science. According to the Independent Commission on Environmental Education (ICEE, 1997, p. 3) environmental education should be "an upper-level multidisciplinary capstone course integrating what students have learned in science, social science, and other upper-level courses." There is no reason that science majors should not benefit from their knowledge or to prevent such "capstone" courses from being developed for science majors, but this would only marginally contribute to our ambitious goal of teaching *all* citizens about biodiversity, as a part of their environmental education. As Aikenhead (1994), based on Fensham (1988), has shown, the emphasis on science and social aspects in STS-curricula can vary from a situation in which most of the emphasis is on the scientific content, to one in which such aspects are mentioned only to establish a link with science. On the continuum between these extreme cases, various decisions can be made, and this is true for environmental education as well as for STS-education. The main idea of many STS-educators is that science, as a part of everyone's general education, cannot and should not be taught in a "top down" manner, by those who know to those who do not. Instead science should be taught in a relevant context, as a functional tool (Solomon, 1994; Aikenhead, 1994).

Biodiversity can provide such a context in which knowledge can be acquired when required.

Fourez (1997) showed a great awareness of the problem of the role of scientific knowledge in education for scientific and technological literacy. In his view it is quite understandable that even involved and literate citizens lack in-depth knowledge about various areas in which public and science issues are linked. No one is a specialist in everything. As implied by Smith (1998), the goal of environmental education cannot be to make every citizen an expert, but rather to give them the ability to ask the right questions and evaluate the quality of available answers. Accordingly, environmental education should provide people with skills that make them able to meaningfully, critically and selectively use scientific knowledge. Such use does not necessarily require a full and thorough understanding of all the concepts involved but rather a more functional understanding of what they do and mean to us in a meaningful context. People may have, for instance, a functional understanding of what photosynthesis does to our environment (adding oxygen, using solar energy to build organic matter, carbon cycle, etc.) without understanding the complex biochemical processes involved in it. In fact, photosynthesis remains, for most non-specialists, a kind of black-box. The main idea is that of showing abstract principles and "theories-in-action" in a concrete situation, instead of dealing with proofs for their existence which remains in the black-box (Olsher & Dreyfus, 1999).

Fourez (1997) also stresses that people must be literate enough to be able to make good use of specialists which includes being able of consulting experts, being able to translate what specialists say, moving carefully from one context to another and discerning any abuse of knowledge. This is a skill that, so he claims, can be taught ("to strike the balance between our dependency on their knowledge and our own healthy critical minds"). These are the kind of science-related skills which environmental education should try to include and tend to be ignored in discussions about environmental education in a postmodern world. Treating the topic of biodiversity within the framework of environmental education requires the ability to use functional scientific knowledge in uncertainty-linked decision making.

3.6 Conclusions

Environmental education in a postmodern world might be tempted to focus on the development of somewhat fashionable – albeit fashionable for good reasons – postmodern ideas related to things like empowerment, respect for pluralism and diversity of thought, action competence, contextual or local knowledge, grassroots decision-making, collaborative and issue-based learning, and so on. Indeed a focus on these components of environmental education is useful and may launch a new generation of environmental educators which is more sensitive to emancipatory learning goals and the contextual, open-ended and uncertainty-linked nature of

the creation of pathways towards sustainability. We believe all this is important, but at the same time would like to stress the importance of the role of scientific knowledge in general and citizen participation in socio-scientific disputes in particular. Biodiversity as an examplary theme for postmodern environmental education illustrates that traditional environmental education approaches fall short in dealing with uncertainty, normative aspects of decision-making and understanding the importance of learning on the edges, which is learning at the cross-points of conflicting worldviews rooted in varying traditions, norms and values.

The topic of biodiversity has great potential for postmodern environmental education when considering its ill-defined meaning, its socio-scientific dispute character and its ability to link science, technology and society. Its ill-defined meaning requires a procedure for making it meaningful in a specific context. Its socio-scientific dispute character requires a procedure for dealing with controversy, uncertainty, diverging values and interests, and moral dilemmas. While its potential to explore, critique and utilise separate ways or systems of knowing and understanding requires a procedure to create a rich context for learning that links scientific, technological and societal expertise and common sense. These aspects are explored in far more detail in the next chapter.

We realise that by placing emphasis on the rationality and justification of learning about ill-defined concepts and on the role of literacy and scientific knowledge, we have somewhat unfairly marginalised the importance of the emotional foundation for such learning. At the same time we have neglected another line of reasoning in favour of learning about such ill-defined environmental concepts: the education for democracy, sustainability and social equity line of reasoning. Those lines of reasoning, to which we have only hinted here but which have been explored elsewhere in this book, provide another case for concepts such as biodiversity and sustainability as suitable themes for contemporary environmental education.

4 STEPPING STONES FOR MAKING BIODIVERSITY MEANINGFUL THROUGH EDUCATION

By Daan van Weelie and Arjen E.J. Wals

4.1 Introduction

This chapter outlines and describes several stepping stones that can be used to contextualise biodiversity for education purposes. With contextualising we mean anchoring a biodiversity concept meaningfully in the thoughts and actions of people in a specific context. These stepping stones or steps should be seen as a starting point for interactive curriculum development. By following these steps and applying the knowledge and experiences of environmental education practitioners, curriculum developers can responsibly and meaningfully integrate the topic of biodiversity in environmental education programmes, for instance, through a process of action research (Wals and Alblas, 1997). The steps are identical to the ones distinguished in the Dutch version of this book (Van Weelie and Wals, 1998).

The steps were derived from a study that consisted of three phases:
- in-depth interviews with experts covering a variety of disciplines (i.e. biology, ecology, philosophy and education),
- a review of selected literature and policy statements, and,
- a two-round Delphi-study that included a variety of groups that are involved in the issue of biodiversity (i.e. teachers, members of youth groups focusing on environmental protection, policy-makers, curriculum developers and environmental educators).

Appendix I outlines and discusses the research methods used. In this chapter we will concentrate on the main outcomes of the empirical study by presenting six essential steps. We should stress that the steps need not be followed in any particular order. Furthermore the curriculum development process requires that each step is revisited frequently to allow for continuous adaptation and improvement of the learning activities. The only reason we begin with 'analysing meanings of biodiversity' is that the topic of biodiversity was the starting point of our research.

Table 4.1 lists the various steps that are part of the stepping stone procedure while Table 4.2 shows the general components and levels of curriculum development.

1. *Analysing meanings* of biodiversity as used in policy documents, scientific literature and the media by comparing them to the general working definition.
2. *Determining perspective*(s) based on general learning goals of environmental education.
3. *Setting concrete learning objectives* that are compatible with the general learning goals, the four distinguished foundations and the selected (sub)themes.
4. *Selecting specific (sub)themes* that complement the perspective(s) chosen.
5. *Contextualising biodiversity* by using the working definition to describe the chosen themes.
6. *Establishing the value of biodiversity* through a process of clarifying, analysing, selecting, acting and evaluating.

Table 4.1 A procedure for developing biodiversity from an environmental education perspective

Level	**Knowledge and value base**	**Concepts**	**Goals**
General	Subject	General definition	General goals
Curriculum	Angles/ perspectives	Contextual definition	Learning objectives
Learning activity	Themes and contexts	Operational definition	Specific learning objectives

Table 4.2 Components and levels of curriculum development

Those who hope this chapter works like a cookbook or a recipe will be disappointed. Although the research did include interviews with teachers, representatives of youth organisations, environmental education consultants, policy-makers, curriculum developers and NGO-workers, its level of abstraction is such that another step is needed to turn it into concrete learning activities. But even though it does not offer recipes, it does provide all the necessary ingredients. When combined with the crucial insights and experience of environmental education practitioners and curriculum developers, we hope this procedure will lead to very concrete and useful educational activities that genuinely tap the educational potential of biodiversity.

4.2 Analysing meanings

Stepping stones
- Analysing meanings
- Determining perspectives
- Establishing learning goals
- Developing themes
- Contextualising
- Valuing

4.2.1 Coping with diverging meanings: a working definition of biodiversity

People having diverse backgrounds talk about biodiversity. Politicians, environmental activists, conservationists, agronomists, foresters, plant and animal taxonomists, geneticists, bio-geographers and ecologists, they all have absorbed and adapted the word biodiversity and talk to each other and to the public, albeit in different languages. All use biodiversity as the hot word in today's small talk, the fashionable keyword to an eloquent but superficial conversation, a worthy successor of earlier panaceas such as ecology, environmental quality, sustainable use or global change (Van der Maarel, 1997, pp.3-4).

As we have seen in the previous chapters, there are many ways of looking at biodiversity depending on how it is defined. When evaluating diversity at, for instance, the level of genes or ecosystems, one will inevitably come across a variety of lenses and instruments with which to observe and measure biodiversity. Hence it is meaningless to state that people should help prevent the loss of biodiversity without specifying what kind of biodiversity is meant, and how it is being measured. It is even possible that one and the same conservation measure can lead to an increase of biodiversity according to one index and to a loss of biodiversity according to another.

When looking at the different meanings the participants in this study attribute to biodiversity, we can find differences between those who emphasise the political strength of the concept and those who emphasise its ecological connotation. According to some, a solid ecological connotation is an essential prerequisite for biodiversity to have any political impact. Others suggest that biodiversity has political impact but a weak scientific (ecological) definition and argue that ecologists only use the concept opportunistically to obtain new research money for already existing research on related concepts.

A distinction can be made between political or symbolical definitions of biodiversity, on the one hand, and scientific definitions of biodiversity, on the other. The symbol of biodiversity refers to the environmental problem of the decreasing variation of life and to the normative demand that we *should* do

something about it. For biodiversity to be a symbolic concept there need not be anything 'out there' that one could identify and name "biodiversity." In other words, as a symbolic concept biodiversity has no empirical reference (Kornet in Ham, 1997). To know exactly *what* is lost, and *what* should be done to stop "biodiversity" losses, scientific concepts or concepts referring to the variety of life with empirical reference are essential. Such concepts refer to entities -phenomena - that can be identified and, indeed, somehow measured. One question we should pose as environmental educators is how to deal with this continuum from strictly political uses and meanings of biodiversity to strictly scientific uses and meanings?

Environmental education about biodiversity should, therefore, not be limited to certain scientific aspects of biodiversity. Values of biodiversity, i.e. economic, aesthetic and ethical ones, should be taken into account as well. In other words, not only one, but many biodiversity concepts and corresponding values and meanings should be treated in environmental education. The selection of what specific or concrete meanings and values of biodiversity should be incorporated in an environmental education programme depends to a large extent on the learners' own ideas, experiences, interests and motivations. At the same time we have to acknowledge that biodiversity concepts cannot be totally contextual and learner dependent. There are resembling features of the various meanings of biodiversity that appear to transcend specific contexts. These resembling features or this family resemblance (Wittgenstein, 1985) need to be described and become recognisable for educators.

A challenge for environmental educators is to give such concepts personal meaning by embedding them in a very specific context in which the learner is or becomes psychologically and physically involved. In order to do so we have to contextualise biodiversity by using a simple working definition that captures the core elements that make up biodiversity:

Biodiversity represents variability (v) in biological entities (b) in a specific space (s) at a specific moment in time (t).

If biodiversity is to become a meaningful concept with an empirical reference, four questions will thus have to be answered:

- *To what biological entities do we give centre stage?* Many different biological entities have been the subject of biodiversity studies, policies and debates. The most common entities used by conservation groups are species and ecosystems, followed by genes, but there are many others (i.e. functional units or guilds, habitats, homogeneous plots, etc.).
- *What kind of variability are we talking about?* Variability is a statistical term that can be used in two different ways: variability as *richness* and variability as *relative abundance*. The former refers to the number of biological entities in a certain location at a certain time. The latter refers to the number of individuals belonging to a specific biological entity in a certain location at a certain time.

- *To what geographical location do we limit ourselves?* Whenever we speak of biodiversity we need to specify in what area this biodiversity can be found or what area we would like to include in, for instance, our monitoring activities.
- *What point in time or time interval will we focus on?* The time factor adds another dimension to biodiversity. Not the distribution of biological entities in space, but the dynamics of these entities over time becomes important here. When we speak of biodiversity loss, for instance, we need to consider both what is actually being lost and over what period of time (at what rate).

These questions can be used to make critical analyses of the various uses of biodiversity, but it can also help a teacher or a group of learners develop a clear focus and sense of direction for an environmental education activity. The more pointed the answers to all four questions, the more focused and fruitful discussions will become on the facts and values related to biodiversity. Using the four questions, learners are able to generate a contextual definition of biodiversity that is immediately relevant to their own interests and concerns. It is clear that to contextualise biodiversity and defuse its ill-defined meaning, all four variables in the definition will need to be specified at some point during the educational process. We will explore each of them further.

4.2.2 Biowhat?

In the Convention on Biological Diversity biological diversity is defined as follows: *Biological diversity* means the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (IUCN, 1994).

In using this definition, the parties of the convention imply that concern about biodiversity should apply to all levels of biological organisation, that all species - at least in principle - are important, and that all types of variability in the living world are to be taken into account. Such a devotion to nature will certainly be a difficult goal to achieve for environmental policy-makers. Likewise, the broad meaning of biodiversity makes it more difficult for educators to select appropriate goals, contexts and contents for learning that transcend formal and disciplinary education and cover all life on earth

The broad description of biodiversity mentioned above may make it easier to communicate the need for nature conservation and environmental protection. However, this definition - or any definition for that matter - is not a straightjacket to be prescribed for all users of the concept. In fact, many other definitions are used, by biologists, for example, and in particular by ecologists.

Ecology literature provides many examples of aspects of biodiversity that can be counted and measured (i.e. Tilman et al., 1996; Huston, 1994; Groombridge, 1992; Solbrig et al., 1992; Walker, 1992; Magurran, 1988; Wilson and Peters, 1988). It is

becoming easier to find such examples because the number of biodiversity titles in scientific literature has grown exponentially in the last ten years (Harper and Hawksworth, 1995). A quick overview of the biodiversity field can be found in Van Nieukerken et al. (1995) from a Dutch perspective, in Groombridge (1992) from a global perspective, in Roos et al. (1992) from an ecological point of view, and in Magurran (1988) from a theoretical perspective. The 1995 supplement of *BioScience* entitled "Science and Biodiversity Policy offers an anthology of prominent American biodiversity authors", *UNESCO Sources* (1994, No. 60 - July-Aug.) and IUCN's *World Conservation* (April 1996) all provide collections of examples and references.

What then do these scientists measure or what kind of empirical reference do they use? Let us look at just one example of a biodiversity classification. Some ecologists, according to Magurran (1988), measure diversity in a certain plot, or they measure differences in diversity between plots. In the first case, *inventory diversity* is a series of *point, alpha, gamma* and *epsilon diversity*.

On the smallest scale is *point diversity*, the diversity of a micro-habitat or sample taken from within a homogeneous habitat. The diversity of this homogeneous habitat is termed *alpha diversity*, and is directly equivalent to the idea of *within-habitat diversity*. The next scale of inventory diversity is *gamma diversity*, the diversity of a larger unit such as an island or landscape. Just as gamma diversity is defined as the overall diversity of a group of areas of alpha diversity, so does *epsilon diversity* or *regional diversity*, the fourth category, refer to the *total diversity* of a group of areas of gamma diversity. Epsilon diversity applies to large biogeographical areas.

Beta diversity is used to describe differences or similarities in a range of habitats or samples in terms of the variety (and sometimes the abundance) of species found in them. One common approach to beta diversity is to look at how species diversity changes along a gradient. This technique is actually used in biology education, although usually not from a biodiversity perspective and not with the aims of environmental education in mind.

Delta diversity, to complete this classification, is defined as the change in species composition and abundance between areas of gamma diversity, which occur within an area of epsilon diversity.

The point is that there are many ways of measuring biodiversity depending on how it is defined. The above 'diversities' apply to species. When looking at diversity at the level of genes or ecosystems we will find even more ways of defining and measuring biodiversity. It is interesting to note that in both conservation and in environmental education that focuses on biodiversity there is a tendency to focus on species.

Table 4.3 provides an overview of the different emphases a biological scientist can use in studying aspects of biodiversity. We should emphasise that this is only one classification and that there are many others.

Genetic diversity
Species diversity • number of species per area (richness) • number of individuals per species per area (abundance) • alpha-diversity • gamma-diversity • epsilon-diversity
Guild diversity
Habitat diversity • within-habitat diversity • niche width • beta diversity (differentiation diversity)
Ecosystem diversity
Landscape diversity

Table 4.3 A classification of biodiversity in the natural sciences (based on Magurran, 1988)

From this discussion of scientific meanings of biodiversity we can already conclude that it is meaningless to state that people should help prevent the loss of biodiversity without specifying what kind of biodiversity is meant. As suggested earlier, it is even possible that one and the same conservation measure can lead to an increase of biodiversity according to one index and to a loss of biodiversity according to another. Therefore, it seems crucial to specify the kind of biological entity being considered in an educational programme or even in a discussion about biodiversity. But there is even more that needs to be specified…

4.2.3 Biodiversity?

Diversity in essence refers to variation or variability. Variability is a statistical term that can be used in two ways in relation to biodiversity. First of all, it can refer to the number of biological entities present in a certain place at a certain point in time. This is known as *richness (*i.e. species richness). The second form of variability refers to differences in the number of individuals of a particular biological entity in time or space. This is known as *relative abundance* (i.e. variation in population size). There is a great number of mathematical formulas available to quantify variability and there are numerous ways of measuring it.

Biological entities are not always easy to count or sample. Particularly amongst plants, the distinction between the individual and the population is often unclear. The strawberry plant illustrates this. The plant makes shoots that can adapt independently to varying environmental circumstances (i.e. variation in daylight and soil humidity). The shoots in a light but dry environment unexpectedly

specialise in photosynthesis activity by forming large leaves. Alternatively, an individual plant responds by developing larger roots to obtain more water. Apparently there is a division of labour among the different parts of the plant that is mutually beneficial.

Another example is reed. Many extended reed stands in wetlands and lake areas turn out to consist of one single plant. The genetic diversity of the reed is therefore negligible, while the relative abundance compared to other plant species gives a distorted picture. Such data suggest that the ecological importance of reed is rather limited, while this is not the case. In this case, the plant's *functional role* in an ecosystem, in part determined by the surface amount it covers, is more fundamental. In other words a different operationalisation of biodiversity is needed here to determine the contribution of reed to biodiversity.

The examples illustrate that the nature of the biological entities chosen as indicators of biodiversity can make the measuring of diversity a rather complicated matter. Education about biodiversity will have to be critical with regard to the methods used to label and measure biodiversity, and will have to show the relativity and limitations of such methods.

The limitations of scientific knowledge about variability are also shown by available data regarding species richness on Earth. Most estimates range between 5 and 120 million species. In addition, some species are exceptional in the number of living individuals (i.e. some ant species). As a result, it is often impossible to count all individuals of a population. In such cases scientists resort to sampling and extrapolation. Such procedures commonly require advanced mathematics. The uncertainty about variability will have to be addressed in educational materials as well. These difficulties and uncertainties with regard to the measurement of variability can be used to illustrate the differences between 'ready-made-science' and 'science-in-the-making' as discussed in Chapter 2.

Table 4.4 illustrates the complexity of variability issues and the consequences of conflicting meanings and value orientations (based on Aan de Brugh, 1996a, b and Corten, 1996).

Herring is an important fish for the Dutch economy. New herring, pickled herring, kipper, no matter how the herring is consumed, it is a species whose numbers are decreasing in the North Sea. It is a well-known fact that the modern Dutch fishing fleet is catching too many herrings. Less known, however, is how biologists compute the *Minimum Biological Acceptable Level* (MBAL) of the herring population or how politicians determine fishing quota.

How many *individual* herrings inhabit the North Sea? In fact, no one really knows or cares since herrings are measured in tons, not in numbers. Measuring this number is inaccurate in principle. Because of the statistical nature of the measuring procedure, i.e. sampling entities that are not spread homogeneously among the

sampled area, a deviation of thirty to forty percent from the calculated value is normal (Aan de Brugh, 1996b). This means that when the International Council for the Exploration of the Sea (ICES) determines the abundance of herrings to be 500,000 tons, the true value could be anywhere between 300,000 and 700,000 tons. Taking into account the economic importance of herring, politicians will tend to base their quota on the risky highest value, instead of the lowest, which would of course be safer for the herring population.

Measuring the abundance of the herring population gives insight into the practical and methodological problems of measuring biodiversity. One way to define fish diversity in the North Sea is by the probability of any two individuals drawn at random from an infinitely large fish community comprised of different species, $D= p_i^2$ (Magurran, 1988). The *Simpson index* $D= (n_i(n_i-1)/(N(N-1)$ is used to calculate the value of D (Magurran, 1988). In this equation 'n' is the number of individuals (or tons) of the species, herring in our example. 'N' is the number of all individual fish. It is not likely that any government would finance the research needed to measure by approximation *this* biodiversity of the North Sea, let alone *the* total biodiversity, considering that the funds for the ICES are too limited to measure even the herring population properly (Corten, 1996). Nature conservation policy-makers will have to do with biased values of economically important species.

Table 4.4 The complexity of measuring variability: the herring case

Obviously, a challenge for environmental educators who wish to focus on biodiversity issues is to reduce the level of complexity to accommodate the level of the learner and a programme's learning goals. When clearly operationalised it is quite possible for grade school children to monitor biodiversity aspects using very simple techniques (see also § 4.8).

4.2.4 Biospace?

Space is another important variable that needs to be specified when trying to understand biodiversity. Species richness, for instance, is only meaningful when referring to the number of species present in a given area. Use of the term richness is only functional when qualifying the plots or areas in which we can find this richness. The size of these plots can vary from a few square millimetres up to a few square kilometres. This also holds true for more exotic forms of biodiversity. Tuomisto and her colleagues (Tuomisto et al., 1995), for instance, used satellite images to measure the habitat diversity of apparently homogeneous low-land forests in the Amazon. As spatial units she used plots of 34.000 square kilometres. Genetic and ecosystem diversity too can only be meaningfully determined by variability per surface area.

A different way of establishing spatial limits to determine biodiversity is the use of geographical borders or natural borders. It is meaningful to talk about the biodiversity of a specific island, for instance, or of the biodiversity of a certain province or country. In the many books and articles that have been written about

biodiversity, maps can be found that depict the distribution patterns of particular species in a specified area.

4.2.5 Biotime?

The topic of biodiversity appears to change like a chameleon when the time dimension takes centre stage as opposed to the spatial dimension. Not so much the distribution of biodiversity over space, but rather the changes of biodiversity over time become the object of study. Perhaps the most extreme example of this is the study of the origins of biodiversity (on Earth): evolutionary biology. To what do we contribute the great diversity of life? How does genetic diversity emerge? How are species formed? Such questions then make up the scientific background of the subject of biodiversity. The word biodiversity in this case refers to the evolutionary issues and not to, for instance, a source of well-being or wealth.

On a smaller scale the time dimension is of importance as well. The loss of biodiversity can only be discussed meaningfully when we ask ourselves: What is being lost? Over what period of time has this loss taken place? At what rate are we losing this biodiversity? In what area is this loss taking place? These questions illustrate the need to specify all four elements of the working definition if educators want to grasp the meaning of biodiversity in a very specific context with very specific learning goals in mind. The normative aspect – which has already been alluded to – comes into play when we also ask the question: Does it matter? We will address this in § 4.7 when discussing the value of biodiversity.

4.3 Determining perspectives

Stepping stones
- Analysing meanings
- Determining perspectives
- Establishing learning goals
- Developing themes
- Contextualising
- Valuing

As has been illustrated repeatedly, the concept of biodiversity can be approached from different angles. From the wide number of ideas put forward by the participants in the Delphi-study, three main perspectives on education for biodiversity could be distilled (Table 4.5). The perspectives are characterised by three general goals of environmental education: ecological literacy, personal growth and development, and an understanding of the socio-scientific dispute character of environmental issues. Within each perspective one of these general goals dominates.

The three perspectives are intended to help curriculum developers navigate through the wide array of possible learning goals and perspectives one could emphasise when focusing on biodiversity. They can help them specify specific learning goals and objectives for education about biodiversity.

A) Ecological literacy
To start with, develop ecological literacy by addressing the intricate relationships that exist between different species that share ecosystems. Proceed by discussing the position of humans within an ecosystem and their impact on it. The learner has to understand the ecological consequences of human behaviour. At the same time, the learner has to see possibilities for averting ecological damage by, among other things, wise use of technology. Key concepts to be included are: species, ecosystems, relationships between species, food webs, nature, human impact, etc.

B) Nature and self
Start by creating opportunities to experience and value nature first-hand. Go outside. A new or renewed relationship with nature could encourage the learner to participate more actively in nature conservation programmes. Any knowledge and understanding needed to experience nature and to participate in conservation programmes can be obtained experientially as the need arises. First and foremost, the learner has to come to love nature and to appreciate its diversity. Special attention will have to be given to active caring for other living things (including fellow human beings). Key concepts to be included are: enjoyment, sense of wonder, appreciation, experience, landscapes, conservation, caring, etc.

C) The politics of nature
Start by raising the issue of a more equitable distribution of natural resources. Highlight and explain important international treaties and conventions. The learner has to understand the way the (international) political arena works, what treaties are and what their impact (or lack thereof) may be. At the same time, the learner has to understand the responsibilities of individual citizens in contributing to local decision making, the democratic process that precedes international treaties, the implementation of such treaties (concrete action at the local level) and the role and position of scientists and scientific knowledge in public decision making. Key concepts to be included are: sustainable development, use of natural resources, North-South relationships, respect, genetic manipulation, exploitation, responsibility, democratic decision-making, ecological agriculture, etc.

Table 4.5 Three educational perspectives of biodiversity as distilled from the Delphi-study

The three perspectives can be useful when analysing existing teaching materials on biodiversity. They have analytical value in that they help clarify and distinguish learning goals, learning activities, learning contexts and associated meanings of biodiversity.

4.4 Establishing learning goals

Stepping stones
- Analysing meanings
- Determining perspectives
- Establishing learning goals
- Developing themes
- Contextualising
- Valuing

Contextualising the concept of biodiversity does not in and of itself guarantee that it will become a suitable topic for environmental education. When developing an environmental education programme we also have to make the transition from an analysis of the meaning of biodiversity and the determination of a fitting perspective to appropriate learning goals. Our research revealed four environmental education foundations for learning about biodiversity: the emotional foundation, the ecological foundation, the ethical foundation and the political foundation (Table 4.6). Although there will be differences in emphasis, depending on the learner, educator, educational setting or available means, all four foundations have to be established if education about biodiversity is to be called environmental education.

- *Emotional foundation*: (re)connecting with nature through discovery and sensitisation, and experiencing biodiversity to create personal meaning.
- *Ecological foundation*: understanding relationships, functions and (global) interdependencies.
- *Ethical foundation*: dealing with values, taking a moral position, raising critical questions.
- *Political foundation*: dealing with controversial issues, making choices, developing action competence.

Table 4.6 Environmental education foundations for learning about biodiversity

The three perspectives from the previous paragraph (ecological literacy, nature and self, and the politics of nature) and the four foundations listed in Table 4.6 can be used to establish learning goals and concrete learning objectives. These goals and objectives should link these perspectives of biodiversity to the specific contents, concepts and themes to be covered in the learning process. Each of the perspectives listed in § 4.3 appears to be compatible with one or two of the foundations listed in Table 4.6 which is not to suggest that educational activities should be limited to one or two foundations or to a single perspective.

At the same time the perspectives and foundations show remarkable compatibility with generally accepted goals of environmental education, i.e. the establishment of:

- personal and emotional involvement in nature and environmental issues,
- personal and emotional involvement in the environment as an issue in society and the community,
- environmental literacy and skills,
- empowerment and action competence, and
- intrinsically motivated change in environmental behaviour.

Table 4.7 shows how different perspectives on biodiversity from an environmental education vantage point can be linked to general environmental education learning goals.

Perspective	Primary learning goal	Secondary learning goals
A) Ecology and society	• Environmental literacy and skills	• Involvement in society and community • Empowerment and action competence
B) Nature and self	• Personal and emotional involvement in nature and environment	• Intrinsically motivated environmental behaviour • Environmental literacy and skills
C) The politics of nature	• Involvement in society and community	• Personal and emotional involvement in nature and environmental issues • Empowerment and action competence

Table 4.7 Linking perspectives on biodiversity to general environmental education learning goals

When developing concrete learning activities we are now able to link the perspectives to potential learning goals for biodiversity within the realm of environmental education.

Learning goals to a large extent influence the contents of a learning activity and the way these contents are taught. The more concrete the learning goals become, the more meaningful they are. Learning goals are, however, not the decisive factor in determining what is actually learnt. The learners themselves - their motivation, their own knowledge, ideas, skill, etc. - are more decisive in this regard. Obviously, any environmental education programme focusing on biodiversity will have to be sensitive to what the learners bring to the programme. The programme will have to be flexible enough to accommodate the specific needs, interests and qualities of the learner.

Other factors that weigh on the learning goals and their chances of being accomplished are: the quality of the teachers and educational support people, existing curricula and/or teaching materials, super ordinate goals set by, for instance, the school, school district, national curriculum or NGO and, finally, available means (financial and human resources, equipment, etc.).

The Delphi-study provided a great variety of examples of learning goals for biodiversity in an environmental education context. This variety is in part the result of the diversity in the groups of people who were asked to participate in the study (secondary school teachers, policy-makers, curriculum developers, environmental educators, NGO-workers, etc.). To illustrate the establishment of learning goals and objectives, we will provide some examples derived from round one of the Delphi-study (see Appendix II). First we will provide examples of individual responses from people representing different groups that participated in the study (which is not to suggest that the examples are representative for the group to which the respondent belongs!). These examples are intended to illustrate the wide range of possibilities. Secondly, we provide examples from round two of the study. In round two all participants were confronted with all the goals and objectives provided in round one and asked to prioritise them. These examples show what goals most participants could agree on.

Example 1 (NGO-worker)
"It is not until people get emotionally involved that they become willing to act. When you're emotionally involved and something goes wrong, it hurts, and it motivates to bring about change to reduce the pain. Acting on the basis of involvement is acting from the heart and soul. This is one of the most important foundations of our very existence."

Potential learning goals
1. The learner can express what he or she would feel when the shrubs and trees behind the school building were converted into a parking lot.
2. The learner is able to develop a plan of action that corresponds with his/her own feelings.
3. The learning is able to put him/herself into the position of others, even into the position of other species.

Example 2 (Environmental educator)
"I like to focus on the development of values, not only because this is important for all realms of life but it is of specific importance with regard to biodiversity and environmental education. The promotion of natural areas that are 'rich' and diverse only resonates with people when they first become aware of their own values. Most people, almost by default, appear anthropocentric, but they must realise that this is a value in itself as well. When talking about genetic manipulation or equity and distribution issues, valuing is more important than knowing. It is not about what is 'good' or 'bad' for the environment, it's about becoming aware that one is a part of it and realising that being a part of it means attributing a value to it."

Potential learning goals

1. The learner understands and is able to illustrate that people are a part of and dependent on ecosystems.
2. The learner is able to provide specific examples of biodiversity reduction (i.e. genetic breeding, monocultures, etc.) and its environmental consequences.
3. Based on the above, the learner is able to present arguments for and against a particular issue, for instance, genetic manipulation.

Example 3 (Group 'miscellaneous')

"In my opinion environmental education should lead to a change in people's behaviour. All other goals should be subordinate to that or be intermediate toward achieving this. Derived from this main goal – and possibly more realistic – the focus could be on: becoming aware of alternative ways of doing things."

Potential learning goals

1. The learner treats nature and the animals and plants that are part of nature with more respect.
2. The learner no longer buys tropical hardwood and opts for a vegetarian meal occasionally.
3. The learner prefers ecologically sound management of urban parks and green zones.

Example 4 (Curriculum developer)

"Change of behaviour, I do not consider an educational goal. Actually, I regard such a goal as a denial of people taking responsibility for their own actions. Instead I would focus on well- argued decision making. This includes things like: concept development and knowledge acquisition in order to be able to argue a point intelligently; values clarification in order to be able to assess, compare, value and make a choice; awareness and consciousness raising in order to be able to determine whether there is indeed an issue or problem; stimulating involvement in order to inspire the motivation to change; and becoming critical of one's own ideas and those of others."

Potential learning goal

1. In a very concrete situation where biodiversity is at stake, the learner is able to take a well-argued stance, which he or she is able to defend when challenged by others.

Example 5 (Environmental policy-maker)

"It's about seeing connections, relationships and the way everything is tied together. But it is also about recognising that biodiversity has both intrinsic and functional value. Understanding that the question 'What biodiversity do we wish to preserve?,' is not an objective question but rather a normatively and politically charged one."

Potential learning goals

1. The learner comes to realise that biodiversity provides the foundation for the continued existence of food cycles, the web of life and all regulatory functions that support these cycles and webs.
2. The learner comes to realise that there is no objective way of deciding how to deal with the loss of biodiversity.

3. The learner comes to realise that Western countries have an international responsibility: our consumer behaviour has a tremendous impact on people and their environments elsewhere.

Example 6 (Teacher)
"The learner must come to understand the biological significance of biodiversity. He or she must understand the basis for this diversity and how this diversity was formed. At the same time it is important to know what functions biodiversity has now or can have in the future, for example, when discussing evolution theory and principles. Additionally, the learner must develop a personal opinion and a critical stance towards the world, particularly with regard to the conservation of biodiversity."

Potential learning goals
1. The learner can understand and explain the development of biodiversity over time.
2. The learner understands the biological advantage of biodiversity and genetic variation.
3. The learner is able to discuss with others the need for the conservation of biodiversity and our own role in contributing to this.

Example 7 (Youth)
"By involving people in all that lives in nature, they will develop a better appreciation of the landscape of which they are a part. Citizens will be less likely to pollute and they will develop an understanding of why space is needed to provide food."

Potential learning goals
1. The learner playfully discovers, i.e. by means of guided tours, the diversity in our immediate environment.
2. The learner comes to realise how much nature provides for our everyday needs (water, paper, nutrition, energy, etc.).
3. The learner is coached to discover and enjoy the esthetical value of our surroundings.

When pressing the participants in round two of the Delphi-study (see Appendix II) to prioritise the learning goals generated in round one, the goals listed in Table 4.8 came out on top.

1. The learner considers the potential impact of his or her actions on biodiversity when making decisions.
2. The learner is able to show how people are part of the web of life with all its cycles and regulatory mechanisms.
3. The learner is familiar with the functional roles of a variety of plant and animal species and with the way they are related.
4. The learner treats the local (natural) environment with more respect.
5. The learner discovers that diversity is beautiful, fun and important.
6. The learner can generate ideas for taking positive action for him or herself, as well as for others.
7. The learner realises that when a certain species becomes extinct, a part of the ecosystem vanishes as well.

Table 4.8 High priority learning goals as determined by the Delphi-participants

It is interesting to note that potential learning goals such as: “The learner is able to imagine him or herself in the position of other species,” “The learner can empathise with others, by seeing the world through the eyes of an inhabitant of the rainforest, for example,” “The learner comes to realise that there are no objective guidelines for dealing with biodiversity” and “The learner decides not to buy tropical hardwood,” did not get a lot of support in round two.

4.5 Developing themes

Stepping stones
- Analysing meanings
- Determining perspectives
- Establishing learning goals
- Developing themes
- Contextualising
- Valuing

In addition to choosing a specific perspective with which to approach the topic of biodiversity and deciding on the learning goals and objectives, it is useful to generate concrete themes. Such themes are needed to make the transition to specific contents, objectives and contexts for learning about biodiversity.

How can we select appropriate themes for learning about biodiversity? This depends on the point of departure of the curriculum development team. We already indicated that the stepping stones which make up the procedure for making biodiversity meaningful, do not have to be utilised in any particular order. The flexibility of the procedure is illustrated in § 4.8 by a few examples of how the procedure can be used.

There are several possible points of departure:
- A specific predetermined meaning of biodiversity (§ 4.2)
- A specific predetermined perspective on biodiversity (§ 4.3)
- A specific predetermined learning goal (§ 4.4)
- Existing teaching materials and activities.

Below you will find five exemplary themes, which are compositions based on the many themes the participants in the Delphi-study nominated for this purpose.

A. Backyard Biodiversity – People are surrounded by animals and plants - many more than you can imagine. The backyard, the school grounds, the balcony and living room all are testimony to this. But if you look closely, you will be surprised to notice so many species that you never encounter. In the soil, under a rock or a brick, processed in everyday tools, foods or materials, even in your own body! Using special observation techniques and instruments, like a magnifying glass or a microscope you can discover more and more forms of life. Take a set of binoculars and look into the branches above your head. Using field guides and reference books you can begin to name and classify the species you come across. This will provide you with a sense of biodiversity in your own local environment. This biodiversity will vary from place to place. Why is this? Investigate what factors influence biodiversity. Without all these different plant and animal species life would be boring, would it not?

- Focus is on the diversity of species in people's homes, schools, communities and backyards.
- Emphasis is on accurate observation, identifying, naming and monitoring.

B. Design a Habitat – Every animal needs other animals and plants to exist. An otter needs fish for food. Water plants are essential for clean water, which both the otter and the fish need.. Every animal is well adapted to its environment, but in urban areas the reverse is possible too: people adapt the environment to accommodate the animals. Small predators, such as the otter, would otherwise hardly exist anymore in a country like the Netherlands. Adaptation and nature creation, a must? Pick an animal you feel connected to or pick a special place on Earth. Design the perfect environment for your animal. A visit to the zoo will enable you to compare your design with 'nature'. You will find seemingly oddly adapted animals and will find an explanation of their natural habitat and co-habitants. Do you recognise some of your own solutions?

- Focus is on the conditions and requirements for species to thrive, survive or take a dive.
- Emphasis is on relationships, ecological principles, factors influencing habitat loss and creation.

C. Biosphere, not Biosfear – The biosphere is the earth's ecosystem. Biodiversity is the diversity of life forms on Earth. All these different species complement each other and keep each other in balance. Life supports life. The biosphere consists of a number of smaller varying ecosystems – ecosystem diversity – such as; oceans and coral reefs, watersheds and rainforests. Such ecosystems are important because of the enormous amount of species diversity they contain. There are many possibilities for learning about this: books, videos, the Internet, zoos, etc. Large ecosystems of significance can also be found in a small country such as the Netherlands. Think of the North Sea or the Waddensea, for instance. These ecosystems are obviously closer to home than the tropical rainforest. Join a

commercial fishing expedition and examine the catch. Or, study the plant diversity in the dunes. Do you see how an ecological balance is preserved? What threats and opportunities do you see?

- Focus is on the biosphere, its ecosystems, their relationships and their life support functions for species, including Homo sapiens.
- Emphasis on understanding global linkages and interdependencies and the notion of a dynamic equilibrium.

D. The Last Dodo...So What? – Everyday astonishing numbers of species disappear, most of which we have never seen or even discovered. In our time more species go than come. In other words, there is a net loss of species diversity. Something to stop and think about… but is this really tragic? Maybe this is just a short period of decline in the Earth's long history during which diversity overall has increased tremendously. Before Homo sapiens walked on this planet, countless species were both formed and became extinct. Think of the dinosaurs that became the victims of a natural disaster. What can we learn from this today? Not everything is our fault! Our behaviour does impact species diversity negatively at times, but so does nature's 'behaviour'! Besides, do we really miss that dodo? Will our grandchildren miss the sable tooth tiger? Organise a forum discussion with guest speakers focusing on the question: 'Which species should we protect and which ones should we allow to become extinct?'

- Focus is on the extinction of species, most of which we have never even known. Questions are raised about the current net loss of species on a global scale. Is it really so bad?
- Emphasis is on values, the role of people in affecting the state of biodiversity and the relationship between people and nature.

E. Shaping Biodiversity – All people depend on the Earth's biodiversity, even the yuppies with their microwave meals. In many sectors in Western society you can still experience this dependency first-hand. For instance in the agriculture, fisheries, tourism and recreation sectors. When talking to people working in these sectors you can learn a lot about biodiversity. Interview for example a forester, a farmer, a policy-maker or a fisherman and he or she will tell you about diversity and how it has changed over time. Select a sector that interests you. Human consumption often negatively impacts biodiversity, but you will see that people can also have a positive impact. How do you make room for biodiversity in an urban setting or in the countryside? Visit some success stories and draw up you own plans for making a positive contribution to biodiversity. Capture as many different perspectives as possible. What are facts and what are myths? What is sure and what is not?

- Focus is on our dependency on biodiversity and the way people shape biodiversity both positively and negatively.
- Emphasis is on values and uses of biodiversity, the impact of consumers and producers on biodiversity and the development of action competence to positively impact biodiversity.

Obviously, the above themes have been derived from people with differing vocations who responded to an extensive survey. When designing a specific learning situation or context, the selection of a theme will also be influenced by a number of conditions or factors: such as the people to be reached, the kind of learning situation (i.e. school-based, community-based, formal, informal, etc.), overall learning goals one has to work within, the environment (and biodiversity) at stake, etc. In every situation, a specific theme to focus on is required to tie specific meanings, perspectives and goals together in a meaningful set of learning activities.

4.6 Contextualising biodiversity

Stepping stones
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- Valuing

On several occasions we have stressed the importance of context in making biodiversity meaningful for a specific group of learners. A big part of the meaning of biodiversity lies in its context. A thorough understanding of the context in which we like to make biodiversity meaningful appears essential. First we must address what is actually meant by the word ‘context’ in this book. Context in the way we use it here refers to a social system of human activities characterised by common knowledge and understanding, shared goals, norms and values, and, finally, a common language. We distinguish between learning contexts and goal contexts.

A learning context refers to the setting in which people learn. This setting is influenced by the learners, the teachers, the educational support people, administrators, policies, available resources, the possibilities and constraints of the physical environment in which learning is to take place, etc. A common language is essential for mutual understanding between all the actors involved. The establishment of common goals does not just refer to general educational goals, but also to creating a safe atmosphere, or a healthy social climate, etc. Goals are not automatically shared by all and they demand continual fine-tuning. Within a context for learning there are usually clear norms: there is agreement on what is appropriate and what is not, about what is expected of everyone, etc. The cultural background of the instructors and the learners form the main source of values that enter the learning process. Many of these values are shared, but some of them are not. These values play a big role in learning within the framework of environmental education.

A goal context refers to the contents of what is learnt. Concepts, subjects, formulas, data, etc., only get meaning when developed, used or analysed within a specific context. This makes it crucial to select appropriate goal contexts for learning about biodiversity. Such a goal context in essence refers to a social system of human activity in which biodiversity plays a central role. Within this goal context biodiversity has a contextual meaning which has been derived from its more general, more abstract, meaning (§ 4.2). For some purposes, i.e. when engaging learners in biodiversity monitoring activities, it will be necessary to operationalise the concept in order to be able to quantify and measure it. In other words, it is possible to complement a contextual definition of biodiversity with an operational definition.

We maintain, therefore, that the context in which learning takes place is essential. In the case of biodiversity, this context needs to be rich enough to make seemingly abstract ideas concrete and relevant to the everyday life of the learner. How can we select rich contexts for learning about biodiversity? Let us provide an example, using theme A from § 4.5.

A. Backyard Biodiversity – People are surrounded by animals and plants - many more than you can imagine. The backyard, the school grounds, the balcony and living room all are testimony to this. But if you look closely, you will be surprised to notice so many species that you never encounter. In the soil, under a rock or a brick, processed in everyday tools, foods or materials, even in your own body! Using special observation techniques and instruments, like a magnifying glass or a microscope you can discover more and more forms of life. Take a set of binoculars and look into the branches above your head. Using field guides and reference books you can begin to name and classify the species you come across. This will provide you with a sense of biodiversity in your own local environment. This biodiversity will vary from place to place. Why is this? Investigate what factors influence biodiversity. Without all these different plant and animal species life would be boring, would it not?

Searching for a clear description of biodiversity for this theme, we use the general working definition: *biodiversity represents variability (v) in biological entities (b) in a specific space (s) at a specific moment in time (t)*. We can generate a contextual definition or description of biodiversity by identifying all elements of the definition using the four corresponding questions:

- What biological entities are focused on in this specific use of biodiversity, if any?
- What kind of variability is referred to by the user of the concept?
- Does the user set a geographical limit or identify a specific region or area?
- Does the user identify a specific point in time or time interval?

Now we can discuss biodiversity in the following manner:

Counting the number of species is important when you want to compare the abundance of two different species, for instance. Based, in part, on such

comparisons, policy-makers can make urban planning decisions. When, for instance, the location of a new development needs to be decided on, the place that will suffer the least ecological damage can be more easily determined when having such data available. You would also need such counts if you wanted to observe changes in species abundance and richness over time. As a result of conservation measures, the water quality in the Rhine River is improving. Ecologists measure this quality by, among other things, monitoring the number and diversity of species.
You observe the biodiversity (V) in your own community directly by monitoring and registering the different kinds of organisms (B) that are there. You can do this pretty much everywhere: in and around the school, in and around your home, etc. You can also monitor whether the number of species is changing over time. For instance, you could monitor how the number of bird species (B) within a 100-yard radius around the school (S) varies from season to season (T) and from year to year (T) by frequently observing these species at set intervals.

From the above paragraphs we can deduce a contextual definition of biodiversity: the species diversity within a specific space at a certain point in time, is the number of different species within that space and in that point of time. Using the theme 'Backyard biodiversity' we can further operationalise such a contextual definition. By organising a variety of learning activities around the subject of species diversity, it can become a meaningful concept to the learners. From the same two paragraphs we can, for instance, deduce an operational definition of species diversity: the number of bird species within a 100-yard radius around the school observed every Friday morning just before school hours in spring, summer, fall and winter between 1998 and 2000.

The above operational definition already suggests very concrete learning activities which require very specific learning goals related to biodiversity: the ability to recognise, monitor and register the different species, as well as the ability to analyse the data and to interpret the results. We begin to recognise elements of perspective A in Table 4.5 on page 53. When the learning activities, in addition to monitoring bird species, also introduce the learners to the characteristics and life-cycle of birds and the web of life of which they are a part, the formation of ecological literacy is the likely result. We recognise an emphasis here on establishing an emotional and, above all, an ecological foundation (Table 4.6 on page 54). However, if the secondary goals (i.e., building empowerment and action competence, and involvement in communal and societal issues) are to be realised as well, such activities will have to be complemented by others. This brings us to another important step in the proposed procedure to give meaning to biodiversity: establishing the value of biodiversity.

4.7 Valuing biodiversity

Stepping stones
- Analysing meanings
- Determining perspectives
- Establishing learning goals
- Developing themes
- Contextualising
- Valuing

We can ask ourselves whether biodiversity has a particular value and, if it does, for whom? Intuitively one is inclined to think 'of course biodiversity is valuable' for 'life' is valuable and 'variation is better than more of the same.' At a very basic level this might be true, but as soon as we go beyond the symbolism and start digging for meaning and empirical references we enter a world of confusion and complexity, as we have already seen in chapter 3 of this book.

The socio-scientific dispute character of biodiversity (see chapter 2), with its underlying political and normative claims, is perhaps most easily demonstrated by the global distribution and equity issues that surround biodiversity. Most of the world's species, for instance, are found in tropical forests in the Southern hemisphere. The protection of the tropical rainforests is mostly promoted by politicians and scientists from the North. How can people from 'the North' expect people from 'the South' to preserve their forests after we have destroyed most of ours in an attempt to gain material wealth and to increase the quality of life? Much of the deforestation is even orchestrated by multinational companies from the North itself... This is just one way of reasoning, of course, but it does highlight the dispute character of biodiversity.

There are many more questions that can be asked about the use and value of biodiversity. Some will argue that its value is in its use and that the trick is to first demonstrate, in economic terms, the contribution biological resources make to the country's social and economic development. Others, recognising a non-economic value of biodiversity as well, have come up with more comprehensive value categories for assessing the value of biological resources (see Table 4.9).

Ehrenfeld believes that discussions about the value of biodiversity serve only one end: delay of action, the continued exploitation of the world's resources and the betterment of a relatively small group of people (Ehrenfeld in McNeely et al., 1990). Wood suggests that, as we saw earlier in chapter 2, humans are in a state of “obligatory dependency on biodiversity.” Due to various, controversial, reasons, biodiversity appears to “beget biodiversity,” to be a necessary precondition for the self-augmenting maintenance of itself. Biodiversity is therefore a necessary precondition for biological resources, and it cannot be traded off. This appears to be its quintessential value. And the conclusion is relatively abstract: any

"resource" may be traded off, by any society, to fulfil its socio-economic interests, or its survival needs, *provided that biodiversity is not depleted* (Wood, 1997*)*.

DIRECT VALUES
Consumptive use value: assessing the value of nature's products that are consumed directly, without passing through a market (firewood, fodder, and game meat).
Productive use value: assessing the value of products that are commercially harvested and sold in a market (timber, fish, ivory, medicinal plants).
INDIRECT VALUES
Non-consumptive use value: contributing to ecosystem functions (watershed protection, photosynthesis, regulation of climate, and production of soil).
Option value: keeping options open for the future (a safety net of diversity).
Existence value: knowing that certain species exist.

Table 4.9 An attempt to establish the value of biodiversity (source: McNeely et al., 1990)

The Delphi-participants generally supported the notion of establishing a political and ethical foundation for biodiversity (§ 4.4) and recognised the importance of sound decision-making, critical thinking and the development of values. So far the proposed stepping stone procedure allows us to:

- move from general learning goals to specific learning objectives
- translate broad and fuzzy concepts of biodiversity into concrete themes which treat specific aspects of biodiversity
- transform the general meaning of biodiversity (as represented by the working definition) into a situated or contextualised meaning.

By contextualising biodiversity we are able to give it meaning in a specific context. However, from an environmental education perspective, it is insufficient to expose learners to a wide array of such contextualised uses of the concept of biodiversity. Even though we now may be able to recognise specific forms of biodiversity within, for instance, our own environment, we have not yet addressed the normative aspects underlying this biodiversity. It is precisely this normative component which is interesting from an environmental education perspective, since it provides access to socio-scientific disputes as described in chapter 2.

The most important pedagogical aspect of entering into a socio-scientific dispute is the inherent possibility of making connections and distinctions between factual and normative claims. The discussions in a socio-scientific dispute can lead to a better understanding of the connections between ecological and environmental issues and their significance for science, technology and society. The meanings of biodiversity that we are able to distinguish by applying the proposed procedure, up until now, are the meanings of different biodiversity concepts in varying contexts.

We can further specify these meanings and contexts by asking questions that reveal its socio-scientific dispute character (Table 4.10).

1. What kind of biodiversity is referred to in this particular situation?
2. What facts are known about this biodiversity; what remains uncertain?
3. What values, claims and uses do the various interest groups attribute to this biodiversity?
4. What values, claims and uses do I personally attribute to this biodiversity?

Table 4.10 Questions to help a learner enter the socio-scientific biodiversity dispute

Answering the first question requires a contextual definition of biodiversity for which the proposed procedure seems adequate. Answering the second and third questions requires some research that could include the questioning of stakeholders. The fourth question should be returning throughout the learning process.

When entering a socio-scientific dispute - which in essence is the clashing of different contexts as defined in § 4.6, i.e. the lack of agreement on goals, norms, values and the absence of a common language - the process of valuing enters the educational programme. This is an enormously complex process that is hard to capture in a linear and prescriptive model. Delhaas and Koekoek (1994) have made an attempt to distinguish various steps in this complex process. Table 4.11 contains a somewhat simplified representation of these steps in the values clarification and development process. The steps can provide some landmarks or beacons to recognise, focus on and to intensify the process. It should be noted that the order in which these steps are followed and the emphasis given to them is not always the same; these depend very much on the person going through this process and the situation he or she is in.

When going through the various steps in Table 4.11 one can take different approaches depending on the learning goals one wishes to emphasise and the group of learners one wishes to reach. For instance, one could take a more emotional approach in which personal feelings and experiences with regard to biodiversity-related issues or elements take centre stage. Or one could take a more rational approach in which the opinions of others on more factual, technical or scientific aspects of biodiversity take centre stage. One could also take a more action-oriented approach in which the development of action competence and a perspective on possible actions or ways to act take centre stage.

1. *Identifying*	• recognising values • labeling your own values and those of others without judging them
2. *Analysing*	• distinguishing the different components of values • recognising the relationships between values • sorting and prioritising values • tracking the source of values • studying the implications of values • exposing contradictions between values
3. *Choosing*	• weighing the consequences of different values • arguing the merits of alternatives • selecting and openly defending the selected alternative
4. *Acting*	• putting your values to work (translating them into actions) • reflecting on the experience
5. *Evaluating*	• determining the value of the selected alternative • determining the value of the perceived consequences of putting the new value into practice • assessing the level of consistency between valuing and acting
6. *Reconsider-ing*	• confirming the choices one has made and accepting their consequences or • reconsidering one's choices in view of one's reflections and evaluations

Table 4.11 Some steps in the values clarification and development process (adapted from Delhaas and Koekoek, 1994, pp. 235-36)

The socio-scientific dispute, with its underlying normative claims, which characterises biodiversity, provides a tremendous challenge for environmental educators. Learners are confronted with many such concepts in everyday life. In the domain of environmental education one can think of sustainable use, sustainability, sustainable development or even nature conservation. Recognising the different political, symbolic and scientific uses of such concepts and making a critical assessment of their strengths and weaknesses, and of their knowledge and value claims, could be an important learning objective in environmental education. Exploring the different meanings, values and uses of biodiversity could easily become a vehicle for the development of critical thinking skills.

In this section we presented the final stepping stone necessary for making biodiversity a meaningful concept for all: valuing biodiversity as part of a socio-scientific dispute. Table 4.11 provides a way of clarifying one's values with regard to biodiversity after the concept has become meaningful (see the other stepping stones) in a specific context. In the next section we will summarise the procedure and illustrate its flexibility by providing two possible applications.

4.8 Examples of using the stepping stone procedure

In this section we will provide two examples of applying the stepping stone procedure. The examples serve three purposes: a) to illustrate that the sequence in which to use the stepping stones is not carved in stone, b) to show how a curriculum development team can deal with 'context', and c) to provide some imagery of the wide variety of possibilities the procedure offers. We should note that, although the procedure has been scrutinised by experts in the fields of environmental education and curriculum development, it has yet to be tested and evaluated in an empirical setting. This phase of the research has just begun and should be completed by the year 2000.

The following examples are not intended to provide a starting point for a group of educational designers and practitioners who want to develop concrete learning activities. After all, in the spirit of practitioner-based curriculum development and collaborative action research, the development of concrete teaching and learning activities should be grounded in the expertise and ideas of educators, educational support staff and (other) learners. *They* will have to determine and agree on a problem statement; themes, goals and objectives; and appropriate learning and instruction tools. The two examples provided here are too isolated to serve as a starting point. They merely provide an idea of how the procedure can be applied.

Example 1 Biodiversity appetiser

A biology teacher has joined a team of environmental educators that wants to develop concrete teaching materials about biodiversity. On Thursday evening, 22 January 1998, he records a National Geographic programme on Channel Belgium 2. His curiosity was piqued by the programme's title 'Savage garden'. The development team had discussed the idea of local biodiversity on several occasions. Based on the discussions, the participants decided on one of the themes listed in § 4.5.

Theme A. Backyard Biodiversity – People are surrounded by animals and plants - many more than you can imagine. The backyard, the school grounds, the balcony and living room all are testimony to this. But if you look closely, you will be surprised to notice so many species that you never encounter. In the soil, under a rock or a brick, processed in everyday tools, foods or materials, even in your own body! Using special observation techniques and instruments, like a magnifying glass or a microscope you can discover more and more forms of life. Take a set of binoculars and look into the branches above your head. Using field guides and reference books you can begin to name and classify the species you come across. This will provide you with a sense of biodiversity in your own local environment. This biodiversity will vary from place to place. Why is this? Investigate what factors influence biodiversity. Without all these different plant and animal species life would be boring, would it not?

The team agrees that this theme corresponds with the “nature and self” perspective on biodiversity to which they wanted to expose people first and foremost.

Perspective B. Nature and self
Start by creating opportunities to experience and value nature fist-hand. Go outside. A new or renewed relationship with nature could encourage the learner to participate more actively in nature conservation programmes. Any knowledge and understanding needed to experience nature and to participate in conservation programmes can be obtained experientially as the need arises. First and foremost the learner has to come to love nature and to appreciate its diversity. Special attention will have to be given to active caring for other living things (including fellow human beings). Key concepts to be included are: enjoyment, sense of wonder, appreciation, experience, landscapes, conservation, caring, etc.

With this theme and perspective in mind, the teacher watches the ‘Savage garden’. The show excites him since it offers a variety of opportunities for in-school learning. Savage garden turns out to be an excellent appetiser for learning about backyard biodiversity (Table 4.12). It does require some editing to cut the length to about 20 – 25 minutes in order to have sufficient time for a proper introduction and discussion.

Savage garden
By using some of the most advanced filming techniques, the hidden flora and fauna in the garden of Leslie Nielsen – a famous American comedian – is captured. The struggle for life is frightening, shocking and disgusting, but at the same time amazingly beautiful and mind-boggling. The film has an ironic undertone and Nielsen sometimes comes across a bit too moralistic. His raised finger could easily be deleted, which would do no harm to the film’s main message and would keep the momentum going.

Table 4.12 Using a video clip as an appetiser for further learning

The flora and fauna in the video is representative of a specific region in North America. The question of what we will discover in our own backyard thus still remains. This is where the design of a series of lessons begins. The stepping stone procedure provides the team with a frame of reference and some pointers for generating specific elements of the various lessons. What we have up until now is:

- a specific perspective: experiencing biodiversity in the local environment of the learner;
- a video as a starting point or motivator for further learning
- a theme: biodiversity in your backyard that you ordinarily would not notice, unless you knew how and where to look and what to look for.

We can now use the working definition from § 4.2.1 to determine what kind of biodiversity we are talking about here:

Biodiversity represents variability (v) in biological entities (b) in a specific space (s) at a specific moment in time (t).

For our theme, species richness appears to be the appropriate kind of variability to address. We are not so much interested in how many individuals of a particular species we find in our backyard. Instead our focus is explorative and of a qualitative nature: we would like to discover as many hidden insect and other animal species as possible. This means that, for now, we will pay little attention to the flora that is also present in our backyard. Of course, a focus on plant species or on the relationship between plants and insects would also have been possible. Such choices in part depend on the conditions (e.g. available time for garden fieldwork), but also on the learning goals the team decides upon. In this case, a learning goal to be realised with the video at the classroom level would be to motivate people to learn about biodiversity. We could state this goal in terms of its intended activity, contents and context.

Learning goal of the video
The learner becomes interested in the intriguing appearances and behaviours of insects and other hidden forms of life and becomes motivated to explore and investigate his or her own garden.

After a short introduction (5 minutes) and the video clip (20 minutes), the remaining 20 minutes of the first lesson are used to reflect on the video, make plans for investigations and form working groups. An important element of the first lesson is that, as part of making plans for investigations, students generate their own questions. The questions they generate are discussed with the teacher and narrowed down to a manageable few that can be explored by various working groups. Some possible questions that could be addressed are:

- What kinds of animal species do you think you will find?
- What will you focus on, where will you look, with what and how?
- What did you find, where?
- What are ‘pests’ in your opinion?
- What was the smallest predator you came across?
- What animals make up the backyard ‘cleaning crew’?
- Why does one garden have so much more hidden biodiversity than another?
- What can be done to increase the hidden biodiversity of a garden, and is this desirable?
- What do the neighbours consider to be a beautiful garden, do they pay attention to (hidden) biodiversity at all?
- How can backyards contribute to more biodiversity in the neighbourhood, village or city?

The students will have to distinguish between main questions and sub-questions. This is how they help determine the direction of their own learning. The context, which has been determined here in part by the theme 'Backyard biodiversity,' can be altered in various ways (i.e. the focus could shift to ecological gardening or perma-cultures or biodiversity as part of Local Agenda 21). The students specialise in the various aspects they wish to explore in relation to biodiversity (here: the current richness of hidden backyard species). In an extended session, the groups present and discuss their results. The presentations will help them broaden their understanding of the subject.

Example 2 Urban rainforest trail

The staff members of an urban environmental education centre would like to develop an activity that shows that the lives of the town's citizens are intricately linked to the well-being of people and species in other parts of the world. Up until now the centre has developed a variety of activities that purely focus on the local environment (i.e. interpretative hikes to help people discover the vast amount of nature that can be found in unexpected places, a water monitoring programme for schools revolving around a local river, a workshop for re-using waste materials, etc.). Inspired by the Local Agenda 21 initiative and the ratification by the national government of the convention on biological diversity, the centre wants to design an eye-opening activity that expands people's horizons. "The trick is," according to one staff member, "to show that local environmental issues and decisions have an impact on the lives of others elsewhere in the world and vice versa." To achieve this goal, the focus of the programme would have to combine the establishment of two different foundations as listed in Table 4.6 on page 54.

- *An ethical foundation*: dealing with values, taking a moral position, raising critical questions.
- *A political foundation*: dealing with controversial disputes, making choices, developing action competence.

The environmental educators stress the following affiliated learning goals:
- personal and emotional involvement in the environment as an issue in society and the community,
- environmental literacy and skills,
- intrinsically motivated change in environmental behaviour.

The perspective that the centre, somewhat unconventionally, would like to focus on is that of the 'politics of nature' (see Table 4.5 on page 53).

Perspective C. The politics of nature
Start by raising the issue of a more equitable distribution of natural resources. Highlight and explain important international treaties and conventions. The learner has to understand the way the (international) political arena works, what treaties are and what their impact (or lack thereof) may be. At the same time the learner has to understand the responsibilities of individual citizens in contributing to local decision-making, the democratic process that precedes international treaties, the implementation of such treaties (concrete action at the local level) and the role and position of scientists and scientific knowledge in public decision making. Key concepts to be included are: sustainable development, use of natural resources, North-South relationships, respect, genetic manipulation, exploitation, responsibility, democratic decision-making, ecological agriculture, etc.

After brainstorming on a variety of activities they could explore, they decide to create an urban rainforest trail with the help of a local pharmacist, a nearby supermarket, a building and construction company, the local "Body Shop" and a clothing store. The idea is that six sites will be developed where people learn about aspects of biodiversity and the way their consumer behaviour is linked to biodiversity elsewhere. For instance, at the pharmacist the sources of a variety of well-known medicines can be traced back to tropical areas. Here the importance of preserving and documenting the gene pool for medical (and other) purposes is explored. At the same time, controversial issues with regard to, for instance, ownership and exploitation could be brought to the forefront. At the building and construction site the different building materials that are in storage have been provided with special labels referring to the materials, source of origin, impact on biodiversity, strengths and weaknesses from both an environmental point of view and a building and construction point of view. The trail hikers also are given a home assessment questionnaire that helps people analyse the materials used for building their own house or apartment. For each material that is damaging to global species richness or genetic variety, an alternative is provided. At the local supermarket people explore the biodiversity aspects of foods (i.e. the number of available apple species now and in the past, the biodiversity index of various meals, etc.).

The team decides on two versions of the trail: a one-hour trail that can be used by school groups, giving sufficient time for a proper introduction of the trail and a good discussion afterwards. This school trail could be used as the kick-off of a series of lessons on biodiversity, since it raises a variety of issues that could be explored further by small groups later on. The other trail version is intended for people visiting the centre during the weekend and lasts anywhere between one and two hours (not all sites have to be visited, there are several possible combinations).

By using the working definition, the staff members discover that at each site the kind of biodiversity that is addressed needs to be made explicit, to ensure that

genetic and species diversity are not used interchangeably, thus creating confusion. By applying the working definition at each site, they are able to assign a specific meaning to biodiversity. At the end of the tour the participants are confronted with the various meanings of biodiversity they encountered.

One of the strengths of the centre is its ability to design the trail in a hands-on fashion by creating a number of opportunities for the participants to discover the biodiversity aspect of everyday consumption. At each site they have a specific activity that requires participants to make a value judgement. Specific questions lead participants into the socio-scientific dispute that surrounds biodiversity. The questions mimic the first three steps in defining the value of biodiversity as listed in Table 4.11 and below.

1. *Identifying*	• recognising values • labelling your own values and those of others without judging them
2. *Analysing*	• distinguishing the different components of values • recognising the relationships between values • sorting and prioritising values • tracking the source of values • studying the implications of values • exposing contradictions between values
3. *Choosing*	• weighing the consequences of different values • arguing the merits of alternatives • selecting and openly defending the selected alternative

It is hoped that the trail will plant enough seeds of dissonance in the minds of the hikers to eventually engage them in the remaining three steps (acting, evaluating and reconsidering).

4.9 Conclusion

We have presented a stepping stone procedure for making biodiversity meaningful based on the two-year empirical study outlined in appendix I. The procedure includes the following steps: analysing meanings of biodiversity, determining one or more perspective based on general learning goals for environmental education, setting concrete learning objectives, selecting specific (sub)themes for learning, contextualising biodiversity and valuing biodiversity. The procedure is intended to help curriculum developers, teachers, educational support staff and environmental education consultants give specific meaning to biodiversity and to help learners critically analyse the way biodiversity is used in science, technology and society. The procedure is an intermediate product to be used in developing specific learning activities and materials that serve various groups of learners.

The procedure shows that it is crucial to learn about different meanings, interpretations and uses of biodiversity and to be able to observe and monitor biodiversity. Equally important, however, is the aspect of establishing the value of biodiversity. The normative character of biodiversity needs to be made explicit in the learning process for it to be called environmental education. To answer the question of whether biodiversity loss is a bad thing, and if so, for whom, one must formulate a personal, well-argued position and reflect on one's own values. In raising such a question we will inevitably have to address the issue of equitable distribution and sustainable use, which are core components of both contemporary environmental education and the Convention on Biological Diversity.

In addition to embedding biodiversity meaningfully in the personal world of the learner, the socio-scientific dispute character of biodiversity needs to be explored as well. Once again the context determines whether this socio-scientific dispute character will be placed in the forefront or the background of the learning process, but it is always present. Viewed as such, learning about biodiversity is highly compatible with environmental education as a continuous learning process that enables participants to construct, critique, emancipate and transform their world in an existential way (Stapp et al., 1996). *Construct* in the sense of building upon prior knowledge, experiences and ideas of the learner. '*Critique'* in the sense of investigating underlying values, assumptions, world-views, morals, etc., as they are part of the world of the learner. '*Emancipate'* in the sense of detecting, exposing and, where possible, altering power distortions that impede communication and change. *Transform* in the sense of changing and shaping the world around them, regardless of scope or scale.

APPENDIX I

RESEARCH APPROACH AND CONSIDERATIONS UNDERLYING THE STEPPING STONE PROCEDURE

Researching the educational potential of biodiversity

The general research question, which was posed to us by the Dutch government, can be formulated as follows:

What are essential criteria, guidelines, principles and constraints when developing the theme of biodiversity within environmental education programmes for people aged 15 years or older?

The answers to this question were to be found within certain parameters known prior to the commencement of the research. To explore biodiversity within the framework of environmental education, attention must be given to the development of the following learning domains: knowledge-insight, involvement-values, responsibility-morality and, finally, skills-action competence. Furthermore, an analysis of the educational potential of biodiversity from the perspective of each of these learning domains would have to be complemented with an analysis of appropriate learning and instruction processes. The essential criteria, guidelines and principles for developing the theme of biodiversity within environmental education were to be synthesised in a foundation and procedure for curriculum development. This foundation and procedure had to be grounded in environmental education and biodiversity literature, in the opinions of experts, and the opinions of practitioners active in (environmental) education or policy-making. Only then would the foundation and procedure be general enough to be adapted to a wide variety of contexts, yet concrete enough to provide practitioners with sufficient imagery for the design of specific learning activities.

In trying to answer the different parts of this question, we made use of three main research tools which would fit the parameters outlined above: expert consultations, literature review and Delphi-study (i.e. Linstone and Turoff, 1975; Mayer, 1996) (Box a).

Overview of the research	
Goal: essential criteria, guidelines, principles and constraints for developing the theme of biodiversity within environmental education programmes	
Method	**Objective**
Expert-interviews	*General orientation* (meanings, values, ethics, philosophy, psychology, policy, environmental education)
Literature review	*In-depth study* (meanings, values, ethics, psychology, instruction, environmental education)
Delphi-study	*Concrete operationalisation* (learning enhancement criteria, objectives, guidelines, perspectives and themes)

Box a Towards a foundation and procedure for environmental education and biodiversity

1) *Expert consultations*. In order to generate starting points for a selective reading of the extensive biodiversity literature, a series of nine expert interviews was conducted as a first step in the research process (Box b). The interviews were conducted with experts from a variety of relevant fields (pedagogy, biology, environmental education, environmental policy,

philosophy of social science and philosophy of biology) to get as many perspectives as possible early on in the research. The interviews were audio-recorded and transcribed for content analysis.

AREA OF EXPERTISE	EXPERTS								
	1	2	3	4	5	6	7	8	9
Pedagogy	X	X	X				X		
Biology				X	X	X			X
Environmental education	X	X	X						X
Environmental policy			X						
Philosophy of social sciences	X						X	X	
Philosophy of biology					X	X		X	

Box b Expertise consulted in expert interviews

2) *Literature review*. We made use of some standard works on biodiversity as a scientific and political concept. Furthermore we included some international policy documents on biological conservation, a review of recent trends in environmental education and some research articles that dealt specifically with biodiversity and environmental education. Our selection was in part based on the expert interviews held earlier. Appendix III contains an overview of the written resources.

3) *Delphi-study*. Biodiversity is a new theme for environmental education. Just as its meaning, value and use were very much in question at the on-set of the research, so was its educational potential from an environmental education perspective. Although it appears that there is consensus at the (inter)national policy level about the meaning and importance of biodiversity, it appears that such consensus is lacking in both the scientific and the environmental education community. If the result of this research - a foundation and procedure for curriculum development - is to be of any use then it is crucial that it be grounded in the experience, ideas, desires and concerns of the various user groups, and that some kind of agreement is reached as to what learning about biodiversity entails. The complexity of the theme and the wide array of possible educational operationalisations made it difficult to satisfactorily identify workable issues, specific needs and individual points of view, and to involve people in the decision making process. Therefore our attention was drawn to the Delphi-method.

The Delphi-process is designed to tackle complex issues by first eliciting opinions or judgements from all respondents, then summarising the various opinions, confronting each respondent with alternative points of view and providing them with an opportunity to revise their original perspective in light of new information. The Delphi process is basically a programme of sequential questioning interspersed with information and opinion feedback (Linstone and Turoff, 1975; Mayer, 1992). The questioning is usually conducted in several rounds using a survey format and carefully selected representatives of groups that are, in one way or another, involved in the issue at stake. Box c shows the Delphi-process designed for the research on environmental education and biodiversity.

The Delphi-study was designed to find answers to two sub-questions that follow from the general research question presented earlier (Box c). The first sub-question (round 1) focused on the content of biodiversity education from an environmental education perspective: to what extent do the participants underwrite the conclusions drawn from the preliminary expert interviews and literature review with regards to the contents of biodiversity education, and what ideas or content elements do they find missing? The second sub-question (round 2) was intended to validate the results from round 1: to what extent do participants identify with the conclusions

drawn from round 1 of the Delphi, and what ideas or content elements do they still find missing? In round 2 of the Delphi the participants were exposed to the ideas offered by other participants in round 1. The participants spent on average 90 minutes on round 1 of the Delphi and 45 minutes on round 2. This suggests that about 80 hours of focused thought went into the Delphi. This input is reflected by the elaborate answers that were given to the more open-ended questions and by the vast amount of commentary provided in the comment section of the more closed questions.

Overview of the Delphi-study	
Goal: mapping contents, contexts and goals for learning about biodiversity from an environmental education perspective, and generating support	
Element	**Objective**
Round 1 Questionnaire	• encouraging creative and critical thought among the participants in order to generate contents, contexts, goals and criteria for learning about biodiversity • analysing and summarising the main arguments put forward by participants for feedback in round 2
Round 2 Questionnaire	• anonymous feedback of selected contents, contexts, goals and criteria and corresponding arguments to all participants • drawing the attention of participants to possibly new issues or sub-questions that emerged from round one which seem of particular interest

Box c Design and objective of the Delphi "Environmental education and Biodiversity"

The participants represented a variety of interests and/or user groups: environmental policy-makers, environmental education resource persons, upper secondary school teachers, curriculum developers, NGO-workers and members of youth organisations involved with environmental issues (Box d). To assure that as many perspectives as possible emerged from the study, a category of people was added which included philosophers, artists and writers. For each category a minimum of five participants were nominated by a key informant who is well known within a specific category.

When looking back at the use of the Delphi-method as one of the research instruments used, we conclude that its explorative value has been reconfirmed here. The answers to the questionnaires (Appendix II) have provided a treasure of information that contributed significantly to the stepping stone procedure and all its elements. At the same time, we must recognise that the wide range and impressive number of, sometimes, disparate ideas that were elicited, overwhelmed the researchers more than once. This vast amount of diverging ideas and information is partly the result of the way the questions were posed and partly the result of the ingenuity and creativity of the participants (who were selected on their ability to contribute meaningfully and extensively to the research from a variety of angles). It was not always easy to utilise all the information provided. Due to time constraints it was not possible to introduce a third round to converge more towards greater coherency and consensus.

Category	n-participants in round 1	n-participants in round 2
Public service workers (employees of a zoo and a museum)	4	4
Environmental educators (employees of a visitor centre and an environmental education centre)	5	5
Youth representatives (employees of a youth organisation)	7	6
Secondary school teachers (specialised in geography, biology or economics)	6	5
Curriculum developers	3	3
Policy-makers (at the national level)	3	2
Miscellaneous (artists, writers, philosophers)	4	2
Total	32	27

Box d Number of Delphi-participants (n) in rounds 1 and 2

APPENDIX II

THE DELPHI QUESTIONNAIRES

Round 1

Part I – Personal data

All your answers will be utilised anonymously in the research report. Nevertheless, we ask you to provide us with some personal data that can help us with the analysis. Even though all individual questionnaires will be coded, we do request that you fill in your name.

Name: .....

Employer/Organisation: .....

Position: .....

Number of years in this position: .....

Gender: male/female (circle one)

PART II – STATEMENTS

Below you will find a number of somewhat controversial statements. Please indicate the extent to which you agree or disagree with the statement. It is important that you defend your choice in the space provided.

Statement 1: *Biodiversity, basically, is a new way of referring to everything to do with the relationship between people and nature.*

Totally agree ☐ agree ☐ agree partly ☐ disagree ☐ disagree completely ☐

Motivation

.....

.....

Statement 2: *The power of biodiversity lies not so much in its biological or scientific significance but much more in its political significance in renewing the attention for (global) nature conservation.*

Totally agree ☐ agree ☐ agree partly ☐ disagree ☐ disagree completely ☐

Motivation

.....

.....

Statement 3: *Environmental educators need to agree on one single definition and meaning of biodiversity for it to have any educational potential.*

Totally agree ☐ agree ☐ agree partly ☐ disagree ☐ disagree completely ☐

Motivation

.....

.....

Statement 4: *The environmental education value of biodiversity is constituted by the fact that it has a variety of different meanings.*

Totally agree ☐ agree ☐ agree partly ☐ disagree ☐ disagree completely ☐

Motivation

.....
.....

Statement 5: *It is quite useful to raise the question of whether it is possible to say that some species are more valuable than others.*

Totally agree ☐ agree ☐ agree partly ☐ disagree ☐ disagree completely ☐

Motivation

.....
.....

Statement 6: *All the discussion about the meaning of biodiversity is unimportant. It's what is behind a concept that is important in education, not how we name or label it.*

Totally agree ☐ agree ☐ agree partly ☐ disagree ☐ disagree completely ☐

Motivation

.....
.....

Statement 7: *Teaching about biodiversity would be incomplete if cultural diversity was left out.*

Totally agree ☐ agree ☐ agree partly ☐ disagree ☐ disagree completely ☐

Motivation

.....
.....

Statement 8: *Nature can best be <u>understood</u> when we distinguish between categories such as: genes, species and ecosystems.*

Totally agree ☐ agree ☐ agree partly ☐ disagree ☐ disagree completely ☐

Motivation

.....
.....

Statement 9: *Nature can best be <u>valued</u> when we distinguish between categories such as: genes, species and ecosystems.*

Totally agree ☐ agree ☐ agree partly ☐ disagree ☐ disagree completely ☐

Motivation

.....
.....

Part III - Concepts

The following two questions (A and B) solicit concepts or ideas that you think are related to or associated with biodiversity. We are particularly interested in concepts or ideas that are of importance to parts of your (volunteer) work that has connections with biodiversity.

Question A: *What concepts or ideas used in your (volunteer) work do you associate with or connect to biodiversity?*

Concepts/ideas

1) .....
2) .....
3) .....
4) .....
5) .....
6) .....
7) .....
8) .....
9) .....
10) .....

Question B: *What concepts or ideas would you want to include most definitely in an environmental education programme focusing on biodiversity?*

Generate a top-five of concepts and ideas that you find most important for education about biodiversity. Use the concepts and ideas you provided in A. Please also indicate why you find a particular concept or idea so important!

Top 5

1) .....
2) .....
3) .....
4) .....
5) .....

Motivation

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

Part IV - Themes (1)

Below you will find three examples of themes that could serve as an impetus for learning about biodiversity. Let your fantasy run wild and generate a theme of your own that you think is suitable for learning about biodiversity. Motivate your choice

based on your own experience and expertise. Subsequently, if possible, provide suggestions for translating the theme into educational activities.

Comment [JOC1]: One cannot 'motivate a proposal'

Sample themes

❶ *Biodiversity on your plate*
❷ *The super potato: blessing or disaster?*
❸ *Nature as neighbour: backyard biodiversity*

Your theme: .....

Motivation:

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

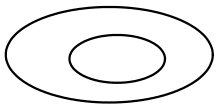
Possible related educational activities:

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

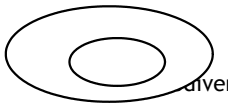
Part V - Themes (2)

In the table on the next page you will find seven themes. How would you classify the relationship between each theme provided in the table and biodiversity?

Choose from the four possible relationships as illustrated below:



A) The theme is part of the larger biodiversity theme.



B) The theme provided is larger than the theme of iversity.

C) The themes partly overlap.

D) The themes have little in common and can be treated ately.

Please use the third column for a brief motivation of your choice!

Theme	Relationship with biodiversity (A, B, C or D)	Motivation
1) Sustainable development		
2) Global dimensions of environmental issues		
3) Transportation and mobility		
1) Local Agenda 21		
2) Environmental management		
6) Violence		
7) Cultural diversity		

Part VI – Learning goals

Below you will find nine possible learning goals for education about biodiversity. Select one goal that you find absolutely crucial or, if you cannot find one, provide one of your own. Please, once again, motivate your choice. If possible, complement your motivation with more specific learning goals that would fit under your main goal.

☐ *knowledge acquisition*
☐ *change in behaviour*
☐ *skills*
☐ *values clarification and development*
☐ *awareness*
☐ *emotional involvement*
☐ *moral development*
☐ *becoming critical*
☐ *forming an opinion*
☐ .....

Motivation

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

Examples of concrete learning goals for the theme 'waste':

(In connection with *skills*)

The learner is able to determine how much paper waste the school creates on an annual basis.

(In connection with developing your *own opinion)*

The learner is able to form a balanced opinion towards nuclear energy and waste and is able to defend this opinion when under scrutiny by others.

Concrete learning goals that fit under the main goal chosen by you:

1) .....
.....
.....
2) .....
.....
.....
3) .....
.....
.....

Part VII – Learning and instruction

Below you find 11 learning enhancement criteria for environmental education (source: Alblas et al., 1993). Mark the one that you consider most crucial for education about biodiversity or, if you cannot find one that suits you best, make up your own. Once again, motivate your choice.

Some learning enhancement criteria for environmental education

☐ *Recognisable* in daily life

☐ *Usefulness* in daily life

☐ Allow for *hands-on, first-hand, experience*

☐ *Build upon prior knowledge and experience of the learner*

☐ Create *cognitive dissonance* to promote alternative ways of thinking and doing

☐ *Problem-based* to promote questioning and further investigation

☐ *Theoretically deepening* to discover underlying principles and ideas

☐ *Discovery-oriented* to foster new learning experiences

☐ *Create social conflict* to involve students in socio-scientific disputes and debates

☐ *Accurate observation* to include all the senses

☐ *Action-oriented* to develop responsibility, care and action competence

☐ .....

Motivation

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

PART VIII - CLOSURE

Is there anything that you would like to add or share that could help us further in our research?

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

How much time did you approximately spend on the survey?

☐ less than 60 minutes
☐ 60 - 90 minutes
☐ 90 - 120 minutes
☐ more than 120 minutes

Thank you for filling out the questionnaire. Please do not forget to return the questionnaire to us using the pre-addressed and postage-paid return envelope. We will send you the results of the analysis of round 1 as soon as possible along with an invitation to participate in round 2.

Round 2

Delphi Questionnaire 'Contextualising biodiversity through environmental education'
Round 2, June 1997

Name: .....

PART I ESTABLISHING CONTENT-AREAS

In round one (Question B of Part III) many participants provided five related concepts or ideas that they thought had to do with biodiversity and their own (volunteer) work. The motives or, in a sense, stories provided for justifying the inclusion of these five concepts tend to relate these concepts or ideas to one another. A few participants provided two to five concepts or ideas that they did not relate. Their motives result in two or more separate stories, each corresponding with one concept or idea. Of all stories provided we distilled the most striking features. Subsequently we grouped all stories that had many features in common. Stories that showed some kind of resemblance were transformed into one composite story. This resulted in three different perspectives on biodiversity for environmental education purposes. We will first present you with the three composite stories that emerged and will then continue with a few related questions.

A) Ecological literacy
Start by developing ecological literacy by addressing the intricate relationships that exist between different species that share ecosystems. Proceed by discussing the position of humans within the ecosystem and their impact they have on them. The learner has to understand the ecological consequences of human behaviour. At the same time the learner has to see possibilities for averting and avoiding ecological damage by, among other things wise use of technology. Key concepts to be included are: species, ecosystems, relationships between species, food webs, nature, human impact, etc.

B) Nature and self
Start by creating opportunities to experience and value nature fist hand. Go outside. A (re)new(ed) relationship with nature could encourage the learner to participate more actively in nature conservation programmes. Any knowledge and understanding needed to experience nature and to participate in conservation programmes can be obtained experientially as the need arises. First and foremost the learner has to learn to love nature and to appreciate its diversity. Special attention will need to be given to the active caring for other living beings (including fellow human beings). Key concepts to be included are: enjoyment, sense of wonder, appreciation, experiencing, landscapes, conservation, caring, etc.

C) The politics of nature
Start by raising the issue of a more equitable distribution of natural resources. Highlight and explain important international treaties and conventions. The learner has to understand the way the (international) political arena works, what treaties are and what there impact (or lack thereof) may be. At the same time the learner has to understand the responsibilities of individual citizens in contributing to local decision-making, the democratic process that precedes international treaties and the implementations of such treaties (taking concrete action at the local level) and the role and position of scientists and scientific knowledge in public decision making. Key concepts to be included are: sustainable development, use of natural resources, north-south relationships, respect, genetic manipulation, exploitation, responsibility, democratic decision-making, ecological agriculture, etc.

Questions

When answering the following questions I have the following 'target group' or audience for environmental education in mind: .....
.....
Motivation: .....
.....
.....
.....

a) Fill out the table below (check a maximum of one box per column)

	A	B	C
I can identify clearly with			
I can identify partly with			
I cannot identify with			

b) What I think is missing in A, B and C (*) is: .....
.....
.....

(*) Circle the perspective that you will be discussing. It is possible to circle more than one perspective. In that case use the back of the page as well.

Part II Learning goals

In round one the participants generated an impressive number of learning goals (75!) for learning about biodiversity within the framework of environmental education. Many of these goals overlap and it appears that two coherent 'goal categories' emerge: goals emphasising human or personal development (using education and environment for improving people) and goals focusing on behavioural change (using education to improve the environment). These differences in emphasis may result in quite a different approach to learning about biodiversity.

LEARNING GOALS	IMPORTANT	UNIMPORTANT
The learner can generate ideas for action from him or herself and for others that positively influence biodiversity.		
The learner understands and is able to illustrate that people are a part of and depend on ecosystems.		
The learner comes to realise that there is no objective way of deciding how to deal with the loss of biodiversity.		
The learner discovers that diversity is beautiful, fun and important.		
The learner understands that when a species becomes extinct, part of the ecosystem vanishes as well.		

The learner becomes critical with regards to the use of the term 'biodiversity' in discussions about global nature conservation.		
The learner can understand and explain the development of biodiversity over time.		
The learner treats nature and the animals and plants that are part of nature with more respect.		
The learning is able to put him/herself into the position of other species.		
The learner is familiar with the functional roles of a variety of plant and animal species and with the way they are related.		
The learner is able to express what in his or her opinion the value is of certain species.		
The learner is able to identify three examples of personal benefits and costs of biodiversity conservation.		
The learner is able to identify the biodiversity within a specific area or plot.		
The learner considers the potential impact of his or her actions on biodiversity when making decisions.		
The learner is able to show how people are part of the web of life with all its cycles and regulatory mechanisms.		

Questions

a) We are asking you to indicate in the table above whether the composite learning goals we derived from round one are important or unimportant to you. It is crucial that you dare prioritise here and make a choice. Therefore we ask you to only check one of the boxes behind each learning goal in order to indicate what you find an important or unimportant learning goal for learning about biodiversity within the framework of environmental education.

b) The goals that I marked as important apply particularly to the following target groups or audiences: .....
.....
Motivation: .....
.....
.....

c) What I find missing in these learning goals is: .....
.....
.....

Furthermore I would like to note that: .....
.....

Use the back of this page for additional comments should the space provided here be insufficient.

PART III CONTEXTS FOR LEARNING

Below you will find five themes that are based on a great number of themes generated by the participants in round one. The motivations provided with the themes have been grouped in a way similar to the 'resemblance technique' described in part I. It is quite possible that you will recognise elements of your own suggestions offered to us in round one, but do also mind the ideas provided by others!

A. Backyard Biodiversity – People are surrounded by animals and plants. Many more than you can imagine. The backyard, the school grounds, the balcony and living room all are testimony to this. But if you look closely, you will be surprised to notice so many species that you never encounter. In the soil, under a rock or a brick, processed in everyday tools, foods or materials, even in your own body! Using special observation techniques and instruments, like a looking glass or a microscope you can discover more and more forms of life. Take a set of binoculars and look into the branches above your head. Using field guides and reference books you can begin to name and classify the species you come across. This will provide you with a sense of biodiversity in your own local environment. This biodiversity will vary from place to place. Why is this? Investigate what factors influence biodiversity. Without all these different plant and animal species life would be boring, would it not?

- Focuses on the diversity of species in people's homes, schools, communities and back yards.
- Emphasis on accurate observation, identifying, naming and monitoring.

B. Design a Habitat – Every animal needs other animals and plants to exist. An otter needs fish for food. Water plants are essential for clean water which the otter needs but the fish need as well. Every animal is well adapted to its environment, but in urban areas the reverse is possible too: people adapt the environment to accommodate the animals. Small predators, such as the otter, would otherwise hardly exist anymore in a country like the Netherlands. Adaptation and nature creation, a must? Pick an animal you feel connected to or pick a special place on Earth. Design the

perfect environment for your animal. A visit to the zoo will enable you to compare your design with 'nature'. You will find seemingly oddly adapted animals and will find an explanation of their natural habitat and co-habitants. Do you recognise some of your own solutions?

- Focuses on the conditions and requirements for species to thrive, survive or take a dive.
- Emphasis on relationships, ecological principles, factors influencing habitat loss and creation.

C. Biosphere, not Biosfear – The biosphere is the Earth's ecosystem. Biodiversity is the diversity of life forms on Earth. All these different species complement each other and keep each other in balance. Life supports itself in a way. The biosphere consists of a number of smaller varying ecosystems – ecosystem diversity – such as; oceans and coral reefs, and watersheds and rainforests. Such ecosystems are of importance because of the enormous amount of species diversity they contain. There are many possibilities for learning about this: books, videos, the Internet, zoos, etc. Large ecosystems of significance you can also find in a small country such as the Netherlands, think of the North Sea or the Waddensea, for instance. These ecosystems, obviously are closer to home than the tropical rainforest. Join a commercial fishing expedition and examine the catch or study the plant diversity in the dunes. Do you see how an ecological balance is preserved? What threats and opportunities do you see?

- Focuses on the biosphere, its ecosystems, their relationships and their life support functions for species, including Homo Sapiens.
- Emphasis on understanding global linkages and interdependencies and the notion of a dynamic equilibrium.

D. The Last Dodo...So What? – Everyday astonishing numbers of species disappear, most of which we have never seen or even discovered. In our time more species go than come. In other words there is a net loss of species diversity. Something to pause for and think about… but is this really tragic? May be this is just a short period of decline in the Earth's long history during which diversity overall has increased tremendously. Before Homo sapiens walked around on this planet, countless species both were formed and became extinct. Think of the dinosaurs that became the victims of a natural disaster. What can we learn from this today? Not everything is our fault! Our behaviour does impact species diversity negatively at times, but so does nature's 'behaviour'! Besides, do we really miss that dodo? Will our grand children miss the sable tooth tiger? Organise a forum discussion with guest speakers focusing on the question: 'What species should we protect and which ones should we allow to become extinct?'

- Focuses on the extinction of species, most of which we have never even known. Questions are raised about the current net-loss of species on a global scale. Is it really so bad?
- Emphasis on values, the role of people in affecting the state of biodiversity and the relationship people-nature.

E. Shaping Biodiversity – All people depend on biodiversity on Earth, even the yuppies with their microwave meals. In many sectors in Western society you can still experience this dependency first hand. For instance in the agriculture, fisheries, tourism and recreation sectors. When talking to people working in these sectors you can learn a lot about biodiversity. Interview for example a forester, a farmer, a policy-maker or a fisherman and he or she will tell you about diversity and how it has changed over time. Select a sector that interests you. Human consumption often negatively impacts biodiversity but you will see that people can also have a positive impact. How do you make room for biodiversity in an urban setting or in the countryside? Visit some success stories and draw up you own plans for making a positive contribution to biodiversity. Capture as many different perspectives as possible. What are facts and what are myths? What is for sure and what is not?

- Focuses on our dependency on biodiversity and the way people shape biodiversity both positively and negatively.
- Emphasis on values and uses of biodiversity, impact of consumers and producers on biodiversity and development of action competence to positively impact biodiversity.

Questions

a) Indicate for what target groups or audiences you find a theme particularly suitable.

Target group/audience for theme A: .....
Target group/audience for theme B:.....
Target group/audience for theme C:.....
Target group/audience for theme D: .....
Target group/audience for theme E:.....

b) Use the table below to indicate what themes you find appropriate for commencing a series of learning activities about biodiversity within an environmental education framework, and what themes you find appropriate for ending a series of such activities. (1x Yes, 1x No), both (2x Yes), or neither (2x No).

TO BEGIN?	THEME	TO END?
YES/NO	A	YES/NO
YES/NO	B	YES/NO
YES/NO	C	YES/NO
YES/NO	D	YES/NO
YES/NO	E	YES/NO

c) Finally we ask you to motivate your answers in the table. Could you explain to us how you determine the usefulness of a theme?

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

Use the back of this page for additional comments should the space provided here be insufficient.

APPENDIX III

BIBLIOGRAPHY

This bibliography contains a variety of written worthwhile resources organised by theme. The resources formed a point of reference throughout the research process. Resources in the Dutch language have been left out. They can be found in Van Weelie and Wals, 1998. Not all of the resources listed here are actually referred to in the text. The titles that have been used in writing chapters 1, 2, and 3 appear in the reference list following the bibliography.

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