
Making biodiversity meaningful through environmental education

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Biodiversity is an emerging theme in science, society and, more recently, education. There is no one single definition of biodiversity that is adequate in all situations. Both the knowledge base and the value base of biodiversity are variable and questionable. Because of these characteristics, biodiversity makes for an interesting vehicle for linking science and society, and the investigation of the normative underpinnings of 'science-in-the making'. Based on a 3-year study, this paper explores the crossroads between science education and environmental education and presents a framework for tapping the environmental education potential of biodiversity. Outlined are a number stepping stones for making biodiversity meaningful to learners. It is argued that, from the perspective of environmental education, the ill-defined nature of biodiversity is a useful feature. Biodiversity is renewing the discourse on nature conservation issues by bringing together different groups in society that are searching for a common language to discuss nature conservation issues in relation to sustainability issues. The resulting debate 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

Introduction

Biodiversity comes in many forms and shapes: in sustainability politics it is valued as a natural resource; in evolutionary theory it is considered both quality of life itself and the product of evolution; in ecology it is sampled, measured and monitored in many different ways to trace complex changes in ecosystems (see, for instance, Magurran 1988, Huston 1994, Rosenzweig 1995, Watson 1995, Takacs 1996). To summarize the conceptual characteristics of the concept of biodiversity it is described in this paper as 'ill defined'. An ill-defined concept cannot be captured by single or universally applicable definitions, can be interpreted in many ways and is hard to define operational even in a specific application domain (van Weelie and Wals 1999). 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.

Yet, not in the least because of the ratification of the Convention on Biological Diversity (CDB) by so many countries – since the UNCED conference held in Rio

de Janèiro in 1992, 179 countries ratified the CBD (<http://www.biodiv.org> 11.30.2000) – biodiversity found its way to the top of international political agendas and, as a consequence, to education. A 3-year educational research project, financed by the Dutch Ministry of Agriculture, Nature Management and Fisheries, was launched to investigate the various meanings, values and uses of biodiversity in order to tap its educational potential more fully (van Weelie and Wals 1998, Wals 1999). The project was to result in guidelines for curriculum design for biodiversity education for both informal and formal environmental education. Furthermore, the project aimed to highlight and study possibilities for educational strategies for teaching and learning about biodiversity. In this contribution we will outline the research project and some of the main results of the research: stepping stones for contextualizing biodiversity from an environmental education perspective.

Environmental education and ill-definition

Since the research presented here was carried out in a Dutch setting, a few words on environmental education in the Netherlands seem appropriate. As has been described in Margadant and Wals (1998) and in Wals *et al.* (1999), environmental education in the Netherlands has first and foremost gained importance because of its potential contribution to resolving environmental issues, and not so much because of its potential contribution to human development. In a sense the environmental justification has, certainly in the past, outweighed the pedagogical justification. More recently, pedagogical and emancipatory considerations are receiving more attention. Two more or less independent developments seem to trigger this: the debate about the emerging ‘education for sustainability’ and a shift in formal education towards self-directed learning.

The emerging education for sustainability – which in the Netherlands is called ‘learning for sustainability’ – can be regarded as a social instrument in environmental policy making, which helps citizens determine their own pathways to sustainable living based on well-informed and critical decision making. At the same time it seeks simultaneously to provide them with the skills and action competence needed to act on those critical choices. The evolution from nature conservation education to environmental education to education for sustainable development is one that can be characterized by an increasing awareness of the need for self-determination, democratic processes, a sense of ownership and empowerment, and, finally, of the intricate linkages between environmental and social equity (Jensen and Schnack 1994, 1997, Hesselink *et al.* 2000). As a result, the educational component of education for sustainability appears to become at least as important as the environmental component (see also Corcoran and Sievers 1994, Gough 1997). This shift in emphasis manifests itself in a heightened awareness of the dangers mixing propaganda, persuasion and inculcation with education (see also Jickling 1997, Wals and Jickling 2000). This heightened awareness could sensitise educators to the ill-defined nature of key emerging concepts such as biodiversity and, indeed, of sustainability itself.

Biodiversity’s ill-definition suggests that there is no single way of describing and interpreting the concept or idea in a way that fits all contexts (van Weelie and Wals 1999). Although such ill-definition could render biodiversity, as a concept, useless or reduce it to a rhetorical instrument from a ‘modernist’ point of view, it

makes it attractive from a more 'postmodernist' perspective. After all, the ill-defined nature of biodiversity or of sustainability, for that matter, suggests:

- the need to respect pluralism (respecting 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, which allows for multiple reality constructions to enter the learning process.

In this contribution we do not consider the ill-defined nature of biodiversity a weakness, but rather as a strength from an environmental *education* perspective. However, this ill-definition is not in and by itself educational; careful guidance is needed to tap the educational potential of ill-definition. In order to find out what such guidance could look like and what is needed to turn this ill-definition into something meaningful for learners, a 3-year study was carried out in the Netherlands with support of the Dutch Ministry of Agriculture and Fisheries.

Researching the educational potential of biodiversity

The original research question posed by the Dutch government, addressed in the first three phases of the research was: What are the basic criteria, guidelines, principles and constraints when developing the theme of biodiversity from an environmental education perspective? As was stated in the original research proposal, the guidelines for developing the theme of biodiversity within environmental education had to be grounded in literature, the opinions of experts, and in the experiences of educators and students. Only then would the framework 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, three main research tools were used: expert consultations, literature review and a Delphi-study. An overview of the research project is displayed in table 1 and discussed below.

Phase 1. Expert consultations

In order to generate starting points for a selective reading of the extensive biodiversity literature, nine experts from a variety of relevant fields (pedagogy, biology, environmental education, environmental policy, philosophy of social science and philosophy of biology) were interviewed. The interviews were audio-recorded and transcribed for content analysis.

Phase 2. Literature review

Scientific and political documents were analysed, including literature on; biodiversity, international policy on biological conservation, recent trends in environmental education, and research articles that dealt specifically with biodiversity and environmental education. The selection was based in part on the expert consultations held earlier.

Table 1. Composition and period of the study.

<i>Overview of the research</i>	
<i>Method</i>	<i>Purpose</i>
<i>Goal</i>	To generate essential criteria, guidelines, principles and constraints for developing the theme of biodiversity within environmental education programmes
Expert consultations (<i>n</i> = 9)	General orientation (meanings, values, ethics, philosophy, psychology, policy, environmental education)
Literature review	In-depth study (meanings, values, ethics, psychology, instruction, environmental education)
Delphi-study (<i>n</i> = 32)	Stepping stones for contextualizing biodiversity education (learning enhancement criteria, objectives, guidelines, perspectives and themes) Scientific theorizing and reporting (publishing the stepping stones (van Weelie and Wals 1998; Wals 1999), and journal articles)

Source: van Weelie and Wals (1999: 81)

Phase 3. Delphi-study

The Delphi-process is designed to tackle complex issues by first eliciting opinions or judgements from all respondents, then summarizing 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 1995, 1996). 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. Table 2 shows the Delphi-process designed for the research on environmental education and biodiversity.

The participants represented a variety of interests and/or user groups: environmental policymakers, environmental education resource persons, upper secondary school teachers, curriculum developers, NGO-workers and members of youth organizations involved with environmental issues. 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 was nominated by a key informant who is well known within a specific category.

Stepping stones for contextualizing biodiversity

Based on the analysis of the data that resulted from the three research phases (abstracted literature, interview transcripts and completed Delphi-questionnaires) a number of stepping stones have been distilled that can be used to contextualize biodiversity for environmental education purposes. Contextualizing here denotes

Table 2. Design and objective of the Delphi ‘Environmental education and Biodiversity’

<i>Overview of the Delphi-study</i>	
<i>Main goal</i> Mapping contents, contexts and goals for learning about biodiversity from an environmental education perspective.	
<i>Element</i>	<i>Objective</i>
Round 1 Questionnaire (n = 32)	Encouraging creative and critical thought among the participants in order to generate contents, contexts, goals and criteria for learning about biodiversity. Analysing and summarizing the main arguments put forward by participants for feedback in round 2.
Round 2 Questionnaire (n = 27)	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

Source: van Weelie and Wals (1999: 83)

the activity of making a concept meaningful in a given context. A simple and everyday version of this activity is the meaningful use of synonyms of a word in different sentences. In this situation the ‘context’ is a sentence, and ‘contextualizing’ means constituting the meaning of the word. More complex contexts are socio-scientific disputes (Bingle and Gaskell 1994) in which key concepts often appear to be rather fuzzy and in need of continuous contextualization. People generally do this just by *using* concepts in their verbal interactions. Mostly, the process of contextualization will remain unconscious. However, sometimes contextualizing needs to be explicated; for example, by defining a key concept. Decisions to contextualize key concepts in specific situations will be motivated by the need to communicate more effectively. Contextualizing in such explicit situations could be seen as a skill. Students can learn this skill by developing concepts explicitly themselves, applying them in different application domains or *practices*, and by using these activities for understanding an authentic socio-scientific dispute. The stepping stones can be tools for helping curriculum developers, teachers *and* learners to contextualize biodiversity. The stepping stones, not listed or to be used in a specific order, are presented in table 3.

The stepping stone procedure was published in Dutch (van Weelie and Wals 1998) and in English (van Weelie and Wals 1999) and presented on various occasions to environmental educators and curriculum developers.

Analysing meanings

A challenge for environmental educators is to enable the learner to attach personal meaning to biodiversity by embedding it in a very specific context in which the learner is or becomes psychologically and physically involved (Wals *et al.* 1999). One of the results of the analysis of the concept of biodiversity was the following ‘working definition’: *biodiversity represents variability (v) in biological*

Table 3. Stepping stones for contextualizing biodiversity.

<i>Determining perspective(s)</i>	Determine pedagogical perspectives and translate them into general learning goals for the educational resource to be developed.
<i>Selecting specific themes and contexts</i>	Select themes and contexts that are suitable for the intended ways of learning and complementary to the general learning goals in the given educational setting.
<i>Analysing meanings of biodiversity</i>	Analyse the meaning of biodiversity as it is used in authentic contexts (e.g. politics, science and the media) relevant to the educational resource to be developed.
<i>Setting concrete learning objectives</i>	Formulate specific learning objectives that are compatible with the general learning goals and the selected themes.
<i>Contextualizing the concept of biodiversity</i>	Attach specific meanings to biodiversity which are useful in the chosen learning contexts and logically consistent with a chosen working definition of biodiversity.
<i>Valuing biodiversity</i>	Design activities for each learning context paying attention to the interests and values of various stakeholders in the socio-scientific dispute about biodiversity.

Note: Based on van Weelie and Wals (1999: 51)

entities (b) in a specific space (s) at a specific moment in time (t) (van Weelie and Wals 1998, 1999).

It is called a *working* definition because it is designed primarily to serve as a tool in curriculum development for biodiversity. Owing to the use of the ‘variables’ *v*, *b*, *s* and *t* it is general enough to cover meaningful contextual definitions of biodiversity in a variety of learning contexts within formal and informal environmental education. It is intelligible from an educational point of view, and yet it covers the way ‘biodiversity’ is used in many political documents, newspapers and journal articles.

Based on this particular working definition, four questions will need to be answered:

- *What biological entities are at centre stage here?* 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, homogenous 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, where and over what period of time (at what rate).

These questions can be used to make critical analyses of the various uses of biodiversity and to 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 might be more relevant to their own interests and concerns.

Determining perspectives

From the wide number of ideas put forward by the participants in the Delphi-study, three main perspectives on education about biodiversity could be distilled: 'the nature and self' perspective, 'the ecological literacy' perspective and 'the politics of nature perspective'. The nature and self-perspective seeks to encourage opportunities to experience and value biodiversity first-hand. Key ideas to be included are: enjoyment, sense of wonder, appreciation, experience, landscapes, conservation, caring, etc. The ecological literacy perspective seeks to develop ecological literacy by addressing the intricate relationships that exist between different species that share ecosystems and by discussing the position of humans within ecosystems. Key ideas to be included are: species, habitat, ecosystems, relationships between species, food webs, nature, human impact, etc. The politics of nature perspective seeks to raise the issue of a more equitable distribution of natural resources and to promote an understanding of the way the (international) political arena works, what treaties are and what their impact (or lack thereof) may be. Key ideas to be included are: sustainable development, north-south relationships, respect for pluralism, exploitation, responsibility, democratic decision making, etc. The perspectives basically correspond with what can be considered three general goals of environmental education: (1) ecological literacy, (2) personal growth and development, and (3) an understanding of the socio-scientific dispute character of environmental issues. Within each perspective one of these general goals dominates.

The three perspectives can help curriculum developers and educators navigate the wide array of possible learning goals and perspectives that can be emphasized when focusing on biodiversity. They can help them specify specific learning goals and objectives for education about biodiversity. The perspectives can also be useful when analysing existing teaching materials on biodiversity. They appear to have some analytical value in that they help clarify and distinguish learning goals, learning activities, learning contexts and associated meanings of biodiversity.

Establishing learning goals

Contextualizing the concept of biodiversity does not in and by itself guarantee that it will become a suitable topic for environmental education. When developing an environmental education programme we also have to relate an analysis of the

Table 4. Four pedagogical arguments for learning about biodiversity (overlap appears to be inevitable and desirable).

<i>Emotional argument</i>	(Re)connecting with nature through discovery and sensitization, and experiencing biodiversity to create personal meaning.
<i>Ecological argument</i>	Understanding relationships, functions and (global) interdependencies.
<i>Ethical argument</i>	Dealing with values, taking a moral position, raising critical questions.
<i>Political argument</i>	Dealing with controversial issues, making choices, developing action competence.

Note: Based on van Weelie and Wals (1999: 61).

Table 5. Linking perspectives on biodiversity to general environmental education learning goals.

<i>Perspective</i>	<i>Learning goals</i>	
	<i>Primary</i>	<i>Secondary</i>
Ecology and society	Environmental literacy and skills (<i>ecological argument</i>)	Involvement in society and community (<i>political argument</i>)
Nature and self	Personal and emotional involvement in nature and environment (<i>emotional argument</i>)	Reflection on role of humans and self in species extinction (<i>ethical argument</i>)
The politics of nature	Involvement in society and community (<i>political argument</i>)	Personal and emotional involvement in nature and environment (<i>emotional argument</i>)

Note: Based on van Weelie and Wals (1999: 61).

meaning of biodiversity (see the working definition) and the determination of an educational perspective to appropriate learning goals. Four pedagogical arguments for learning about biodiversity surfaced in the study: the emotional argument, the ecological argument, the ethical argument and the political argument (table 4). Although there will be differences in emphasis, depending on the learner, educator, educational setting or available means, all four arguments have to be addressed somehow if in the end education about biodiversity is to be called environmental education.

The three perspectives presented earlier – ecological literacy, nature and self, and the politics of nature – and the four arguments listed in Table 4 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.

Table 5 shows how different perspectives on biodiversity from an environmental education vantage point can be linked to more general environmental education learning goals. When developing concrete learning activities curriculum developers and educators might now be better positioned to link the perspectives to potential learning goals for biodiversity within the realm of environmental education.

Developing themes

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 found useful by many of the Delphi participants to generate concrete themes for learning. Such themes appear necessary to make the transition to specific contents 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 teaching and learning development team. We already indicated that the stepping stones that make up the procedure for making biodiversity meaningful, do not have to be used in any particular order.

There are several possible points of departure:

- A specific explicit and predetermined (i.e. by those involved in the designing, teaching and learning process) meaning of biodiversity.
- A specific explicit and predetermined perspective on biodiversity.
- A specific explicit and predetermined learning goal.
- Existing teaching materials and activities.

Five exemplary themes, which are compositions of the many themes the participants in the Delphi-study nominated for this purpose, were generated. Table 6 contains brief descriptions of each of the themes. The content of the exemplar themes – which are described in more detail in van Weelie and Wals (1998, 1999) can be contested and should only be considered as a starting point for exploration and reflection, and not as prescriptions for teaching and learning.

The five exemplary 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 including: 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 seems essential to tie specific meanings, perspectives and goals together in a meaningful set of learning activities.

Valuing biodiversity

The Delphi-participants generally supported the notion of establishing a political and ethical foundation for biodiversity and recognised the importance of sound decision making, critical thinking and the development of values. By contextualizing biodiversity it can become meaningful in a specific context. However, from an environmental education perspective, it is insufficient to expose learners to a wide array of such contextualized uses of the concept of biodiversity (contextualizing as a means) or even to develop the learners' ability to contextualize (contextualizing as an end). Even though we may be able to recognize specific forms of biodiversity within, for instance, our own environment, we will also need to address its underlying normative aspects. It is this normative component which is interesting from an environmental education perspective, since it provides access to the socio-scientific disputes referred to earlier.

Table 6. Some exemplary themes for education about biodiversity.

<i>Theme</i>	<i>Focus</i>	<i>Emphasis</i>
Backyard biodiversity	On the diversity of species in people's homes, schools, communities and backyards.	On accurate observation, identifying, naming and monitoring.
Design a habitat	On the conditions and requirements for species to thrive, survive or take a dive.	On relationships, ecological principles, and factors influencing habitat loss and creation.
Biosphere, not 'biosfear'	On the biosphere, its ecosystems, their relationships and their life support functions for species, including <i>Homo sapiens</i> .	On understanding global linkages and interdependencies and the notion of a dynamic equilibrium.
The last Dodo ... So what?	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?	On values, the role of people in affecting the state of biodiversity and the relationship between people and nature.
Shaping biodiversity	On our dependency on biodiversity and the way people shape biodiversity both positively and negatively.	On values and uses of biodiversity, the impact of consumers and producers on biodiversity and the development of action competence to positively impact biodiversity.

Note: Based on van Weelie and Wals (1999: 65–66).

The normative aspects underlying a socio-scientific dispute in which biodiversity is at stake can be brought to the forefront by asking some key questions (van Weelie and Wals 1999: 71): (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 individuals personally attribute to this biodiversity? 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 different stakeholders and interest groups. The fourth question should recur throughout the learning process. 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 buzzing confusion and stubborn complexity. When entering a socio-scientific dispute – which in essence is the clashing of different contexts, 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 a very 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 7 contains a somewhat simplified representation of these steps in the values clarification and development process. The steps can provide some markers to recognize, focus on and intensify

Table 7. Some steps in the values clarification and development process.

<i>Identifying</i>	Recognizing values Labelling your own values and those of others without judging them
<i>Analysing</i>	Distinguishing the different components of values Recognizing the relationships between values Sorting and prioritising values Tracking the source of values Studying the implications of values Exposing contradictions between values
<i>Choosing</i>	Weighing the consequences of different values Arguing the merits of alternatives Selecting and openly defending the selected alternative
<i>Acting</i>	Putting your values to work (translating them into actions) Reflecting on the experience
<i>Evaluating</i>	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
<i>Reconsidering</i>	Confirming the choices one has made and accepting their consequences or Reconsidering one's choices in view of one's reflections and evaluations

Note: Adapted from Delhaas and Koekoek (1994: 235–236) in van Weelie and Wals (1999: 72).

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 and highly depends on the context or the situation and the person going through this process.

The most important pedagogical aspect of entering a socio-scientific dispute appears to be 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.

We have presented six stepping stones for contextualizing biodiversity from an environmental education perspective. The stepping stones are intended as guidelines or points of reference for both curriculum development and learning about biodiversity. In other words, curriculum developers could use them in developing the content, goals and process of teaching about biodiversity. At the same time, the stepping stones might become an integral part of the learning process itself.

Discussion

The ill-defined nature of biodiversity appears to be a useful feature from the perspective of environmental education. Biodiversity is renewing the discourse on nature conservation issues by bringing together different groups in society that are searching for a common language to discuss nature conservation issues in relation to sustainability issues. The resulting debate allows the socio-scientific dispute character of 'science-in-the-making' to surface (Bingle and Gaskell 1994). Participation in such a dispute is an excellent opportunity to learn about a highly relevant, controversial, emotionally charged and debatable topics at the crossroads of science, technology and society (Latour and Woolgar 1979, Fensham 1998,

Bybee 1991). The socio-scientific dispute, with its underlying normative claims, which characterizes biodiversity, provides a tremendous challenge for educators. Learners are confronted with many such concepts in everyday life. In the domain of environmental education, but also of contemporary biology education, one can think of concepts such as: sustainable use, sustainability, sustainable development and even nature conservation. Recognizing 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 in different contexts, could be an important learning goal of environmental education.

The Delphi-phase of the research weighed heavily on the construction of the stepping stones. When looking back at the use of the Delphi-method, we conclude that its explorative value has been reconfirmed. The answers to the questionnaires have provided a wealth of information that contributed significantly to the stepping stone procedure and all its elements. At the same time, we must recognize 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.

Although the Delphi-method did include a variety of groups preoccupied with environmental education and/or biodiversity, relatively little attention was paid to the perspective of the learner (although representatives from youth organizations were included in the Delphi). This was generally considered a weakness of the study which is why this is the subject of current educational research in the Netherlands on biodiversity as a theme for learning (see, for example, Van Weelie 2001).

The stepping stones imply that it is crucial (a) to learn about different meanings, interpretations and uses of biodiversity, (b) to be able to observe and monitor biodiversity, and (c) to critique its conceptual use in environmental and political discourse. There is a fourth, equally important aspect, which is the establishment of values 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 almost inevitably the issues of equitable distribution and sustainable use – both core components of both contemporary environmental education and the Convention on Biological Diversity – will need to be addressed.

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 (Wals 1996): *construct* in the sense of building upon the prior knowledge, experiences and ideas of the learner; *critique* in the sense of investigating underlying values, assumptions, world views and interests, 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.

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