THE INFUSION OF ENVIRONMENTAL EDUCATION INTO THE BIOLOGY CURRICULUM: A NEW ROLE FOR EVALUATION

Dr D.R. Schreuder

INTRODUCTION

To date the efforts to make pupils more aware of the environment and instilling in them a sense of responsibility towards it have taken place mainly outside the formal education sector. It appears that those school subjects which are supposed to introduce pupils to aspects of the natural environment are still taught as if there were nothing wrong with the environment and as if the environment were just another curricular terrain.

However, there are indications that, mainly as a result of increased public pressure and the efforts of dedicated individuals, the formal education sector will eventually have to accept responsibility for assimilating the principles of environmental education in school curricula. The *White Paper on Environmental Education* (Department of Environment Affairs 1989) seems to support this. It should be accepted that environmental education will neither be introduced as a new school subject, nor will new syllabi accommodating the objectives of environmental education be developed within the foreseeable future. Introducing environmental education either as a cross-curricular element, or as syllabus inserts in a number of school subjects might well be encouraged, and it might become the responsibility of teachers to develop curricula aimed at encouraging positive pupil attitudes towards the environment. Biology could well be regarded as one of the key initial footholds in this process.

This implies that the emphasis in biology education in particular will have to shift towards a holistic approach which will acknowledge the importance of exposing the learner to the total environment with a view to optimise potentialities - not only intellectual potentialities, but also psycho-social, physical, aesthetic, and spiritual. This essentially implies that adaptations will have to be made to didactic approaches, intercurricular cooperation and evaluation. Environmental education as a function of good, basic education could therefore serve as an important "...stimulant for change..." (O'Donoghue 1986:3), and classroom evaluation practice is but one of a number of areas which would benefit from the introduction of this process.

The crucial role of evaluation and assessment in education has long been accepted. Both serve not only to gather information on pupil's development and progress, but also expose learning needs and lacunae which should enable the teacher to make informed decisions on curriculum materials and methodology. Evaluation instruments will have to be developed that will enable teachers to collect information on pupil perceptions about aspects of the environment. (Student perceptions are defined as "...states of awareness of aspects of the external world and the interpretation and evaluation of these" (Schreuder 1990:37). Perceptions, together with a tendency to act, could therefore be regarded

as important co-determinants of attitudes.)

This will not only enable teachers to develop curricula suited to the needs of pupils and society more effectively, but should also enable them to monitor the development of positive attitudes towards environment in pupils.

There are indications that in a complex society such as exists in southern Africa, culture, ethnicity and socioeconomic circumstances greatly influence perceptions about the environment (Le Roux *et al.* 1988:78), and this should be considered in the development of curricula. It is therefore important to develop evaluation instruments which can be used to gather information to enable the teacher to formulate relevant and suitable curriculum objectives and to choose suitable curriculum materials and methodologies.

This development should be regarded as an attempt to encourage the gradual introduction of environmental education into formal education, thereby complying with some of the recommendations contained in the *White Paper*.

RATIONALE FOR A DIFFERENT APPROACH TO EVALUATION

The mere fact that the success of any environmental education experience depends entirely on the extent to which cognitive, affective and skills objectives are achieved, warrants a broader approach to curriculum evaluation in formal education. "Educational" assessment and evaluation is often based on the Tylerian principles of measurement of (cognitive) outcome, serving only to inform the teacher on how well cognitive objectives have been achieved by the learner. This results in the deleterious tendency characterising current education to over-emphasise examinable content at the expense of aspects such as the development of positive attitudes.

Evaluation of cognitive outcome alone as a result of some learning experience, too often based on the logical-positivistic assumption that only that which is directly measurable is worth teaching, would not serve any of the objectives of environmental education. By definition evaluation should serve a much more important function than this. The assessment of aspects such as perceptions about, or attitudes towards the environment, both before and after a learning experience, must be regarded as essential components of an environmental approach to teaching.

It is therefore necessary to reflect on some current viewpoints on a broader approach to evaluation.

THE ROLE OF EVALUATION IN CURRICULUM DEVELOPMENT

The broader role of evaluation is aptly described by Stufflebeam (1983:118): "The main purpose of evaluation is not to prove, but to improve".

To achieve this, it would seem necessary to evaluate throughout the development and implementation of a curriculum, starting even before any educational programme is designed.

The schematic representation (fig. 1, adapted from Passineau 1984) of the function and place of evaluation in environmental education illustrates this view. Evaluation, in the form of continuous

collection of information at various steps of the development of the curriculum, is a continuous and refined process to ensure that the information elicited in each step is cycled back to where reforms and adaptations can be effectuated.

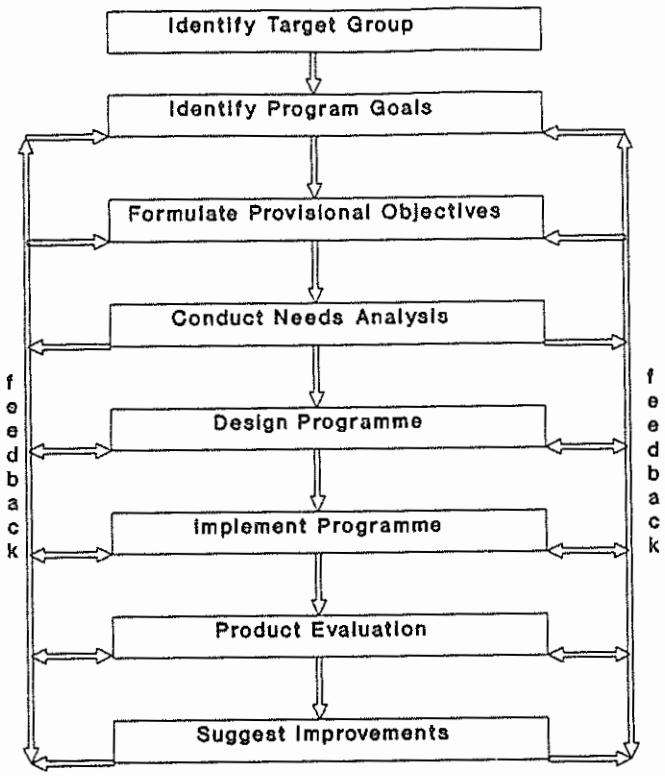


Figure 1: Model of Evaluation in Environmental Education, adapted from Passineau (1984:376).

In contrast to the long established practice of using only the results of assessment of curriculum outcome - often exclusively cognitive - as feedback, all the steps in this model depend on the feedback supplied by the continuous evaluation of a variety of aspects.

This approach is accepted by many educational researchers. In their description of **illuminative** evaluation , Parlett and Hamilton mention two important aspects: evaluation of the instructional system and the learning milieu. Both these depend on the collection of relevant information.

Stake (1983:304) likewise stresses the importance of this broader paradigm in suggesting methods that he has termed "antecedent conditions evaluation", and "transaction evaluation", with the former in particular including elements of needs analyses. This aspect is also emphasised by Eisner (1985, as quoted by Human 1986:16) when he states:

> If the experiential background of students is so remote from the content encountered as to make it essentially meaningless, it is obvious that the curriculum, regardless of how defensible on other grounds, is inappropriate for that population.

The CIPP Model for Program Evaluation described by Stufflebeam (1983) is particularly relevant. One of the chief motives for the development of this model was the difficulty of formulating curriculum objectives for a specific product evaluation exercise as "...the needs of the students were highly variable and had not been the subject of serious study, and ... no common set of objectives could have been responsive to their varied development levels and needs" (Stufflebeam, *op. cit.*:121). This model confirms the need for the development of additional evaluation instruments to assist teachers in the development of environmental education curricula.

The development of evaluation instruments to collect information on aspects of pupil behaviour toward aspects of the environment may assist the teacher in the process of **context evaluation** to answer some of the following questions: "What

needs are addressed, how pervasive and important are they, and to what extent are the project's objectives reflective of assessed need"? (Stufflebeam, *op. cit.*: 124).

A teehnique that might enable teachers to conduct this type of "research" to assist them in the development of suitable curricula has been developed and field tested and will be discussed in the next section. This technique could meet some of the important demands of not only context evaluation, but of evaluation at other stages in the process of curriculum development.

USING VISUAL STIMULI AND OPEN RESPONSES TO EVALUATE STUDENT PERCEPTIONS ABOUT THE NATURAL ENVIRONMENT AND CONSERVATION

The technique and the most significant results described below, are fully described in a doctoral thesis entitled: "Determining pupil orientation toward the natural environmental and conservation" (Schreuder 1990).

In developing the technique the following assumptions were made:

STUDENT PERCEPTIONS

Perceptions have earlier been defined as states of awareness of aspects of the world, and the interpretation and evaluation of these. Investigating perceptions would therefore involve analysis of at least cognitive and affective (value) elements in an elicited verbal statement.

VISUAL STIMULI ARE MORE SUITABLE FOR ELICITING RESPONSES THAN QUESTIONS

It was assumed that a visual stimulus (line drawings proved most effective) depicting selected concepts and issues related to the environment would stimulate different types of responses, depending on how sensitized the respondent was toward the concept. Various perceptions would therefore be reflected by responses varying in quality to the same stimulus. Visual stimuli were used for the following reasons:

(1) Concepts can be concealed to various degrees, thereby facilitating differentiation;
(2) Concepts that are difficult to describe without giving some clues in a verbal description are more easily portrayed;
(3) Reading fatigue is minimised.

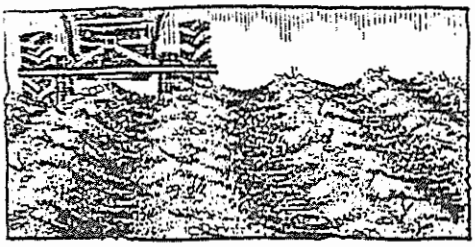
The illustrations on p. 15 were used in the survey.

THE QUESTIONS ACCOMPANYING THE VISUAL STIMULUS ARE OF KEY IMPORTANCE

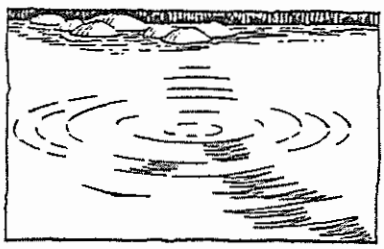
After extensive field testing it was found that the minimum number of questions that could be asked with each visual representation were:

(1) "What does the picture tell you?" (eliciting cognitive responses, referred to as cognitions), and
(2) "How do you feel about it?" (eliciting affective responses, reflecting values held toward the particular aspect.)

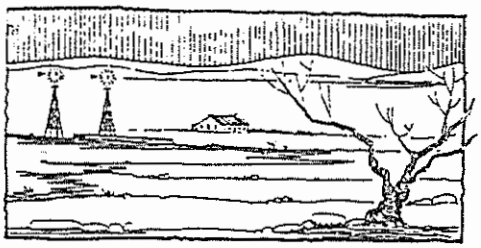
In evaluating the responses, it was accepted that



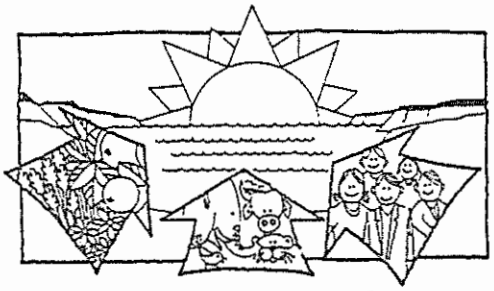
Soil



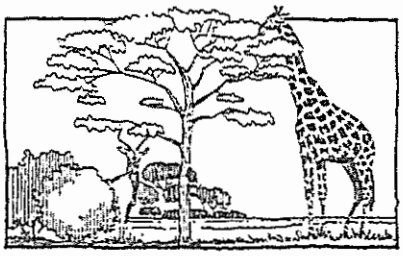
Water



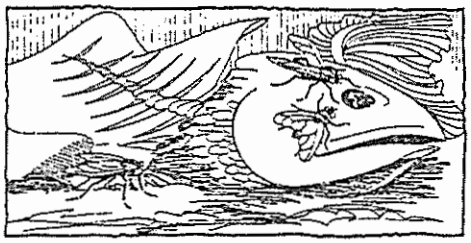
Drought



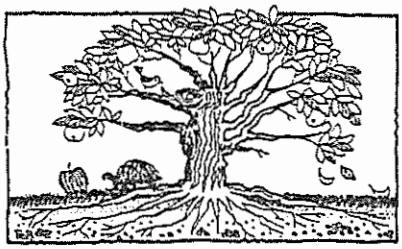
Dependency



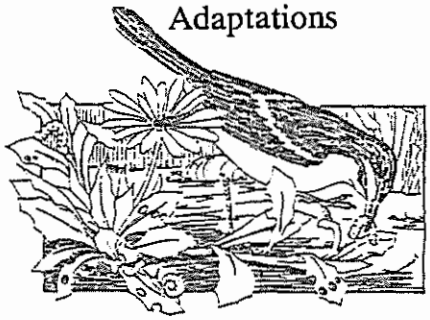
Adaptations



Decomposers



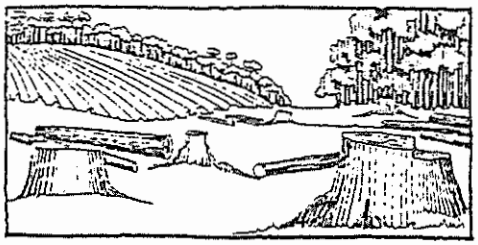
Role of Trees



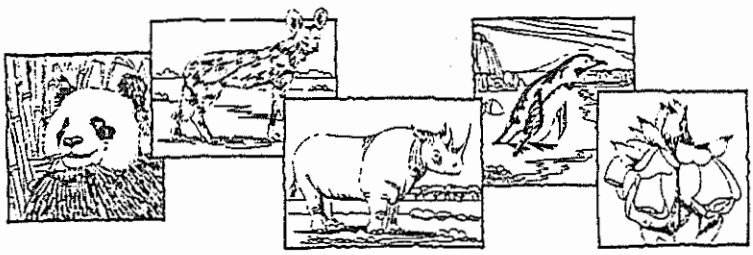
Food Chains

Soil Erosion

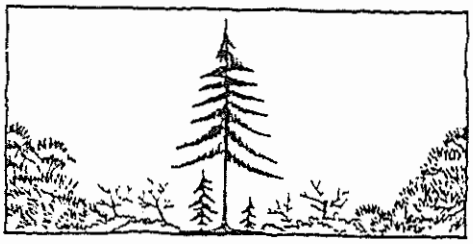
Pollution



Deforestation



Endangered Species



Invader Plants

affective responses in reaction to the first question would also be regarded as valid, and *vice versa.*

OPEN RESPONSES YIELD BETTER QUALITY INFORMATION THAN STRUCTURED RESPONSES

Respondents were asked to respond to each of the questions in a single sentence in the language they feel most comfortable in. It was assumed that by so doing, better quality information could be generated, as respondents would not be limited by preconceived alternatives (choices). By identifying certain key terms and expressions for each response, it would be possible to differentiate between responses.

These assumptions were based on a number of field tests, during which various aspects of the technique were refined and validated. For the more statistically inclined, it would appear difficult, if not altogether impossible, to assess effective elements in this manner, but for the purpose of generating information and mere categorisation of responses, the technique proved to have exciting potential. However, in the actual final field test the responses were coded, and the results subjected to rigorous statistical analyses. It was concluded that if necessary, and if certain guidelines in respect of analysis and coding of the responses were adhered to, the instrument would yield dependable, valid and very useful results (Schreuder 1990:125-128).

THE QUESTIONNAIRE SURVEY, AND SOME TENDENCIES IDENTIFIED

THE CONCEPTS SELECTED

The concepts that were selected for inclusion in a questionnaire for the final survey were selected on the basis of being either basic ecological concepts (soil, water, interdependency, food relationships, the role of trees, adaptation and decomposition) or environmental issues (drought, soil erosion, pollution, deforestation, invader plants and endangered species). A set of line drawings were selected after extensive field testing, and the questionnaires were completed by 611 standard six pupils from white, coloured and black schools in the Western Cape.

Although it was not the original intention, the survey was repeated after nine months during which some of the respondents (the experimental group) were subjected to an education programme addressing most of the concepts and issues. A marked difference was recorded between the responses of this group and a control group, confirming two hypotheses:

(a) the instrument could successfully be applied to differentiate between pupils on the basis of their perceptions about environmental concepts and issues;

(b) Apart from its potential in context evaluation, it could also be useful in product evaluation, especially where it is important to establish whether the pupil's affective aspects have changed.

SOME NOTEWORTHY RESULTS

General

(a) A marked consistency between the quality of cognitive and affective aspects in most of the categories could be identified. Where the quality of cognitive responses was low, a corresponding low quality affective ("values") response was recorded. This seems to support the idea of Triandis (1971:3) that a "... cognitive representation ... is the minimum condition for having the attitude ...", and stresses the importance of understanding certain basic ecological concepts in developing positive attitudes about the environment and conservation.

(b) It was clear from the first few categories that pupils generally are not used to expressing emotions or feelings about concepts. This must have affected the results and also stressed the importance of applying teaching methods where such opportunities are possible.

(c) Visual representations were remarkably effective in eliciting responses, and differentiated between respondent's perceptions about the concepts in question. Linked to open responses, the information elicited was very informative.

(d) Certain tendencies in individual schools (e.g. exceptionally high or low quality responses with regard to either cognitions or values for specific categories) could be directly related to specific educational experiences, as all such cases were investigated by interviewing teachers.

Differences between the responses of black and white respondents

Although it was not the purpose of the investigation to compare white and black respondents, some tendencies were identified that indicated fundamental differences in perceptions that could possibly be related to a combination of influences, of which socio-economic conditions and cultural differences are probably the most important. Some of the most significant of these differences are discussed.

* Soil:

  Substantially more black (8,2 %) than white (2,4 %) respondents expressed man's dependence on the soil for food. "Soil is our mother...", and "...everything grows in soil. I feel good because we depend on plants..." were frequently encountered among the black pupils' responses.

* Water:

  An even more significant difference between white and black respondents was recorded in this category. In the affective section 59,7% of black respondents recorded scorable responses as opposed to 17,1% of the white group. A disproportionally high percentage (88,8%) of the white group did in fact not recognize the concept as opposed to only 18% of the black group. Black respondents in particular expressed their dependency on clean water and the need to keep it clean and use it sparingly.

* Deforestation:

Another noteworthy difference between black and white respondents was recorded in this category. While exceptionally strong emotional responses against the removal of trees were generally recorded among the white group, black respondents referred to the economic role of trees in firewood, furniture and houses, and only 10 % expressed emotions about forests being destroyed. This utilitarian view likewise came to the fore in other concepts where trees were featured (role of trees, erosion, plant invaders). A similar tendency among black Americans was identified by the research of Kellert in his study of American attitudes towards animals (Kellert 1980:96-7).

* Pollution:

Only 2,8 % of the black respondents mentioned the term pollution in response to this category, while the whole group, the average scores of this item were substantially higher than for most of the other. White respondents in particular expressed strong aversion, while black respondents mainly focused on the water and its possible uses (or being unfit for use), and objects floating in the water (empty bottle that can be

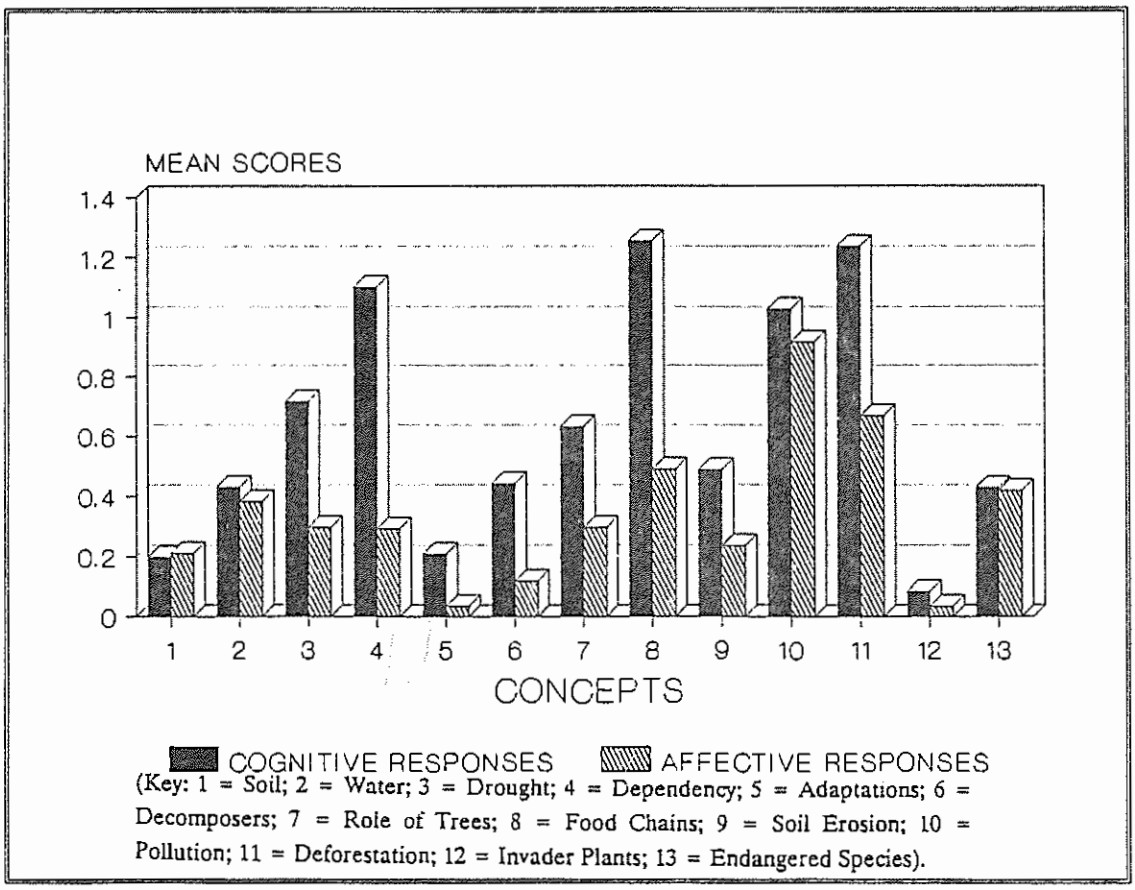


Figure 2: Mean scores for cognitions and values per concept

exchanged, orange can be eaten, tin might contain jam).

* Endangered species:

  Only a relatively small percentage of white pupils recognized the concept, although some black respondents expressed some sympathy towards animals in general.

Other findings

As can be seen from the representation, concepts such as food chains, dependency on resources, pollution and deforestation recorded relatively high cognition scores, while deforestation and pollution recorded the highest values scores. It is interesting to note the substantial differences in scores (c and v) for the concepts dependency and decomposition, the latter probably because of aversion having been expressed towards the flies on the rotten fish. There can be little doubt that the illustrations had something to do with some of the trends, but on the whole it can be assumed that the majority of respondents are unfamiliar with concepts such as niches (and adaptations), decomposers and recycling, invader plants, the importance of soil and water for life and endangered species. In the post-test, after these issues were specifically addressed, the scores were markedly higher.

Also evident is an obvious inability to express emotion about these concepts. This could probably be explained by either the pupils not being used to expressing emotions, or the absence of strong feelings for these concepts.

No marked differences could be identified between English-speaking and Afrikaans-speaking respondents, but the means for both categories were higher for male than female respondents. City-dwelling respondents recorded lower means in both categories than rural respondents.

CONCLUSION

There can be little doubt that further experimenting with and development of this technique is warranted by the very interesting and useful nature of the information gained. It is doubtful if any other technique that teachers have access to has similar potential.

A number of instruments that could be used for similar purposes have been studied in the course of this development, but these normally have features that make them unsuitable for teacher use. They normally depend on complicated and specialised statistical analyses, and are therefore only accessible to "evaluation experts". Teachers usually regard the findings of such tests with suspicion.

The techniques applied in most of these instruments for assessing affective aspects (values, attitudes) are also highly controversial, as most of them depend on structured, multiple-choice type responses. The results of the technique described in this paper confirmed that it is highly unlikely that any expert can ever hope to anticipate all possible expressions of either cognitions or affect among a given population. This is especially true in the case of black respondents, and any findings involving this type of technique must be regarded as somewhat dubious.

Student teachers at the Education Faculty at the University of Stellenbosch have been trained in the application of this technique in curriculum development. The feedback has been decidedly positive.

For environmental education to be successfully infused into formal curricula, teachers will have to be equipped with the necessary strategies that would enable them to develop curricula based on existing syllabi and on identified learning needs among their pupils. This will ensure greater relevance and satisfy some important requirements of environmental education. The hope can only be expressed that in due time this and similar techniques may be further developed as "tools of the trade" of environmental education.

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