

A CRITICAL REVIEW OF SOME TEXTBOOKS USED FOR THE TEACHING OF ECOLOGY IN STANDARD 8 BIOLOGY

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ABSTRACT

Quantitative and qualitative analyses of prescribed standard eight biology textbooks are discussed in relation to the teaching of the ecology syllabus, an area which is very important in understanding the bio-physical aspect of environmental education. The analysis identifies some of the problems of relying solely on prescribed texts for instruction and considers some of the facets that need to be addressed in the compilation of texts for use by teachers and pupils.

INTRODUCTION

A pilot survey of biology teachers involved in teaching the standard eight biology syllabus has been conducted by Wagiet (1991). The area of assessment was related to the content and methodology of teaching the ecology section, as a vehicle for environmental education at this level. Three issues were discussed: the pre-service training; the time used for teaching the content, and the resources available to the teacher. The survey indicated that textbooks are by far the most used resource of the teachers and it is this aspect which is addressed in this paper.

Textbooks are generally used as a means to acquaint learners with subject matter and as a method of instruction and therefore occupy an indispensable place in any educational system

(Engelbrecht 1975). In most cases textbooks do not only prescribe what should be taught in the classroom, but also how the teaching should take place, in other words, they also prescribe to a certain extent on methodologies. Therefore the textbook may assist the inexperienced teacher, but it may also create a dependency, leading eventually to a teaching situation where the teacher merely reads from or repeats what is stated in the textbook.

The unique value of the textbook is that it offers the teacher an explanation of the syllabus. This view is supported by Diepeveen (1982 in Ballantyne *et al.* 1988), who established that 80% of geography teachers in the Cape Education Department, used the textbook as a syllabus guide instead of the syllabus itself. Gould (1977 in Wegerhoff 1981) reported that the textbook was used in more than 60 % of lessons in biology, and teachers therefore regard it as a very important teaching aid.

In the study by Wagiet (1991) 87 % of the respondents indicated that no other literature other than the prescribed textbooks had been utilised in the teaching of the ecology section. Appreciating the significant role which this important learning tool plays in the teaching process, careful compilation and selection of suitable textbooks is crucial. The centralised nature of the educational system complicates matters in this regard, since

schools are supplied with a list of prescribed books. Nevertheless, the final selection from the recommended list lies with the school and thus teachers may contribute towards the selection of a particular textbook.

A general analysis of the textbooks used by the respondents in Wagiet's (1991) work is reported on together with a more detailed analysis of the most popular text used by the respondents. This latter facet is discussed in relation to three sub-sections of the syllabus, namely nutrient cycling, symbiotic relationships, and conservation. These three sub-sections had been identified as the most difficult, neither difficult nor easy, and the easiest respectively by the survey, and formed the background for the analysis of the textbook.

Of extreme importance in issues of this nature is the readability of the textbook which is the main thrust of this paper. Gilliland (1976) associates the concept of readability with one of matching. He regards it as matching a reader with a text.

Readability is governed by:

- the ease of reading;
- the ease of understanding, and
- the ease of finding a text interesting.

These three facets are aptly summarised in a definition by Dale and Chall (1948 in Gilliland 1976)

In the broadest sense, readability is the sum total (and interaction of) all those elements within a given piece of printed material, that affect the success which a group of readers have with it. The success is the extent to which they understand it, read it at optimum speed, and find it interesting.

Wegerhoff (1981) examined Physical Science textbooks at various Cape Education Department schools in terms of readability, and suggested that the following criteria should be considered before purchasing a specific textbook:

- language simplicity;
- adequate coverage of the syllabus;
- an appropriate and interesting style of writing by the author(s), which may include, for example, the use of humour, personal and historical anecdotes;
- word density per line, and the number of syllables per word;
- line density per page, and the average sentence length;
- capitalisation on the interest of learners;
- use of colour for emphasis, illustration, diagrams, etc;
- inclusion of short progressive summaries, and suitable home and practical activities for pupils; and lastly
- the cost involved.

Implicit in the above criteria are certain methods applied for the selection of appropriate textbooks, for example:

- subjective assessment (illustrations, activities, content, style of writing, format and organisation);
- readability formulae (syllables per word; words per sentence). Perrera (1980) claims that measures of word difficulty and sentence length used in formulae are shown to have weaknesses, since short familiar words are not easy to read in all contexts, and that long sentences are sometimes easier than short ones. In the absence of quantitative methods, most assessments pertaining to the

readability of a textbook are subjective in nature, which is also the most commonly used method for the selection of textbooks.

Although readability formulae can provide adequate guidelines for the selection of biology textbooks, some are rather difficult to apply at times, since tables, illustrations and specialist vocabulary may form an integral part of the text. The more suitable means of judging textbooks in biology would then be a subjective type of analysis, which, where appropriate, can be used in conjunction with certain readability formulae. Nonetheless, the teacher will need to have some knowledge on factors governing the selection of textbooks, if they have to make a choice in this matter. Some of the above mentioned criteria are discussed in an attempt to evaluate the readability of certain areas in the most frequently utilised textbook authored by Claassens *et al.* (1985).

BRIEF ANALYSIS OF TEXTBOOKS USED BY RESPONDENTS

The following list of standard eight biology textbooks were used by teachers in the survey of Wagiet (1991).

- A. Claassens, A.J.M. *et al.* 1985. *Biology. Standard 8.* Juta, Cape Town.
- B. Du Toit, J.J. *et al.* 1985. *Senior Biology Standard 8.* Nasou, Cape Town.
- C. Austoker, J. & Wessels, H.J. 1986. *Biology for Today. Standard 8. Higher and Standard Grade.* Juta, Cape Town.
- D. Smit, A.L. *et al.* 1986. *Senior Secondary Biology. 8.* Maskew Miller Longman, Cape Town.
- E. Ayerst, P.W. *et al.* 1985. *Exploring Biology. 8.* Schuter & Shooter, Pietermaritzburg.

Textbook	% using textbook	no. of pages	No. of pages on ecology	% of book devoted to ecology
A	94	289	77	26
B	33	246	83	33
C	31	204	44	21
D	23	293	61	20
E	23	296	93	31
Average	-	265	71.6	27

Table 1: Percentage use by respondents of the five biology textbooks and quantitative representation of the ecology section

Table 1 indicates that the majority of the respondents in the survey used the text of Claassens *et al.* (1985) although other textbooks were used in conjunction with it. The table also indicates that between 21 and 33% of the content pages are devoted to the ecology section.

Considering that about a quarter (25 %) of the standard eight biology syllabus is allocated to ecology (details in Appendix four of Wagiet 1991) then, ideally, an appropriate textbook would have a quarter or more of it's information allotted to content on ecology. If numbers were the only criteria to be applied, books C and D would be less suitable than the others.

However it is not the quantity that is of importance here, but rather the quality. One important aspect of quality is that the linguistic standards must be appropriate (Engelbrecht 1975). In this respect, the language used in the book should match the linguistic competence of the pupil, and this should include the home-background of the pupil, since the lower the socio-economic circumstances, the more vital the instruction in the language becomes.

READABILITY ANALYSIS OF ONE TEXTBOOK

The text by Claassens *et al.* (1985) is analyzed in terms of the amount of information it contains on the various sub-sections on ecology, and it is linked

SUB-SECTIONS OF ECOLOGY SYLLABUS	PAGES	PERIODS
A. Practical study of ecosystem, with emphasis on the relationship between it's components	11	3
B. Abiotic components: [physical; edaphic; physiographic]	22	3
C. Biotic components: Producers; Consumers- herbivores, carnivores and omnivores; Decomposers.	3	3
D. Biological Rhythms	2	2
E. Symbiotic relationships	4	3
F. Trophic levels	5	3
G. Nutrient cycling	4	3
H. Biosphere	1	2
I. Ecosystems: Aquatic and Terrestrial	1	2
J. Man and Ecosystems: Pollution	6	2
K. Conservation of indigenous flora and fauna	4	2

Table 2: Number of pages covered in Claassens *et al.* (1985) and the average number of periods used by teachers for each sub-section of the ecology syllabus.

to the number of 35 minute periods used by the teachers to teach the respective sub-sections. Two interesting points need to be raised from the summary in Table 2. Firstly, can the specific amount of content (as indicated by number of pages) be covered adequately within the amount of periods as indicated by the sample? Secondly, is the content and readability of the textbook suitable to satisfy the needs of the teacher, and does it meet the requirements of the pupil?

Three sub-sections, nutrient cycling (most difficult); symbiotic relationships (neither difficult nor easy) and conservation (easiest) will be reviewed in terms of how they are presented in the textbook, which is utilised by 94 % of the respondents in the survey.

NUTRIENT CYCLING

This sub-section is covered in four pages in the textbook (Table 2) and the amount of periods utilised to teach this sub-section corresponded to the amount recommended by the educational authorities. However, after having scrutinised the content it was found that:

- a great deal of chemistry, which is rather abstract in nature, is embraced in this sub-section as indicated by the following extract:

The nitrogen cycle

The atmosphere consists of about 78 per cent nitrogen, the main source of nitrogen required by plants and animals to build up protoplasm, muscle tissue, hair, bone, cartilage, etc. Animals and plants cannot use atmospheric nitrogen. Plants obtain nitrogen from nitrates. A nitrate is a NO_3^-

compound, eg. NaNO_3 (sodium nitrate). Plants absorb nitrates in the form of negatively charged ions (anions), i.e. NO_3^- ions.

The process by which atmospheric nitrogen combines with oxygen to form nitrates is called nitrogen fixation.

- the inclusion of specialist / technical terminology is abundant as the following extract shows:

Ammonification

Certain bacteria change urea and uric acid into ammonia (NH_3), most of which occurs in the soil as ammonium ions (NH_4^+).

Nitrification

Nitrite bacteria change ammonia into nitrites (NO_2 compounds), which are not taken up by plant roots. Nitrite bacteria change nitrites into nitrates (NO_3 compounds). Nitrates are absorbed by plant roots as NO_3^- ions.

- a rather compressed form of writing is evident as illustrated in the extract below:

Root nodule bacteria

These bacteria are not free-living but occur in large numbers in the roots of leguminous plants such as lupines, lucerne and sweetpeas. The bacteria occur in the swellings (nodules) of the roots, where they transform atmospheric nitrogen present in the soil into nitrates (Fig 1.74). Most of the nitrogen thus fixed is taken in by the host plant which supplies the bacteria with dissolved carbohydrates manufactured in the leaves (mutualism).

Denitrification

Denitrifying bacteria present in

the soil release nitrogen from nitrates and in doing so restore nitrogen to the atmosphere as nitrogen gas (N_2).

- In a few cases there is more than one idea / process contained in one single sentence. Should these be broken up into a number of simpler sentences, it would facilitate the ease of reading and understanding of the passage, for example:

By this process the radiant energy of the sun is used to combine with carbon dioxide with the hydrogen present in water molecules to form high energy carbohydrates. Oxygen is released during this process.

In this single sentence, at least four concepts are involved:

- * radiant energy from the sun and its fixation;
- * CO_2 present in the atmosphere;
- * process of water uptake from the soil, and
- * the production of carbohydrates by means of photosynthesis.
- Furthermore intricate chemical cycles / pathways are illustrated which require in-depth explanation to the pupils;
- Illustrations / drawings are limited, since only one drawing is included for this entire sub-section.

If one views this information in terms of the textbook being a self-instructional medium, or for unsupported study, then this text has major limitations.

This sub-section is further sub-divided into the following sections:

- carbon cycle;

- nitrogen cycle;

* Nitrogen fixation

- (1) electrical fixation;
- (2) nitrogen fixation by bacteria;
- (3) protein synthesis
 - (a) de-amination,
 - (b) ammonification,
 - (c) decomposition,
 - (d) nitrification.

The foregoing paragraphs indicate that nutrient cycling covers a wide range of topics. Ideally, more information on each aspect is required, and not just mere paragraphs as it is presented in the textbook.

Since the role of the textbook in the teaching of biology cannot be over-stressed, there is a great possibility that the information, as contained in the textbook will be imparted as is, to the pupil. This compressed, highly technical and condensed form of writing is not suitable for the pupil, and in most cases, not for inadequately trained teachers either.

Furthermore it is questionable whether this type of information can be taught effectively within the three periods recommended by the authorities and also utilised by the teachers. It is more likely that six to seven teaching periods will be needed to cover this section. Protein Synthesis on its own is an intricate process to understand. To include it at this point, in passing, furthermore reflects the weakness in the way the syllabus is constructed, since the physiology thereof is only dealt with at standard nine level. Yet, it is expected of the pupil in standard eight to understand the significance thereof.

SYMBIOTIC RELATIONSHIPS

This sub-section of the ecology syllabus was neither regarded as interesting, nor difficult, hence, it is regarded as an intermediate sub-section. The recommended time for teaching, and the amount of periods actually used by the sample (Table 2) was found to be the same, and the sub-section is covered in four pages in the textbook.

Relating to the content, symbiosis essentially covers three forms of relationships, ie. parasitism, mutualism and commensalism. Pertaining to its presentation, the following are important:

- the sub-section starts off from the known, essentially linking up to the pupil's standard six knowledge, as indicated by the following extract:

Symbiotic Relationships

In standard six you learned that there are three major forms of symbiosis, and you studied examples of each kind.

- the author(s) identify with the reader by using user-friendly terms such as, "we", for example:

We shall refer to examples of each kind of symbiosis again and discuss one example of each in more detail.

- each type of symbiotic relationship is adequately described, and sufficient diagrams and illustrations are used to substantiate them. This is in direct contrast to what has been established in the case of nutrient cycling, where only one illustration has been included.

On the negative side, in certain places, the sentences seem to be lengthy, and could be broken up into simpler, smaller and more effective sentences, in order to facilitate the ease of reading and understanding.

In general, symbiosis, as opposed to nutrient cycling is much simpler and easier to understand, and, hence, presents no real problem for the teacher to teach.

CONSERVATION

This sub-section was identified as being the most interesting area. It is covered in four pages in the textbook, and unlike the aforementioned sub-sections, there is a definite discrepancy between the time recommended to teach it (6 periods) and the actual time utilised by the teachers in this sample (Table 2). Teachers should, however, bear in mind that this is one of the most important sub-sections in the entire ecology section that can be used to facilitate environmental awareness, and it is highly recommended that more time be spent on this. A more free style of writing is evident in this sub-section than the other two sections. By the frequent usage of "we" and "our", the authors identify with the readers and the "story-telling" style of writing increases the interest facet of readability. In addition sufficient pictures are included to reinforce the facts, capitalising on the pupil's interest, and capturing their attention.

It is noticeable that the level of difficulty varies substantially within the same textbook. This correlates to the Mallinson studies (1950-57, in Wegarhoff 1981) where it was established that the levels of reading difficulty within the same

textbook may vary greatly. In the present analysis the readability level is clearly correlated with the respondents' ability to teach the various sections. It is not completely clear how this relationship is affected by the nature (difficulty) of the content and this facet needs to be addressed. A further point that is disturbing is that such a variety of styles and thus readability are found in a single textbook which may of course be a consequence of multiple authorship.

CONCLUSION

Textbooks are of fundamental importance in senior secondary education, and this accentuates the importance of the compilation and selection process. Teacher training institutions and publishers should take note in this regard. The necessary skills which accompany the selection process need to be more critical of their tasks. In addition teacher training institutions need to carefully analyse their own syllabi to prepare teachers for the shortcomings of prescribed textbooks.

Having stated this, it has to be remembered that the readability of a textbook depends in part "crucially on the personality, attitude and internal emotional state of the pupil" (Wegerhoff 1981). Even the best textbooks can be rendered ineffective by such factors, which are beyond the control of the textbook writer. There is nevertheless plenty of scope for the improvement in the readability of presented textbooks, an issue which is vitally important in South Africa where there are many unqualified as well as under-qualified teachers.

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