# THEMES, DREAMS AND REALITY: THE SCIENCE PROJECT APPROACH TO CURRICULUM DEVELOPMENT IN BIOLOGICAL SCIENCE

**Margaret Keogh**

The evolution of thinking and the development of materials relating to the biological component of the Science Education Project are outlined. The context of the project within Southern African society and its relationship to curriculum development theory are examined and a number of possible models for the dissemination of knowledge are discussed.

## INTRODUCTION

Science Education Project (SEP) is a non-profit making educational trust which aims to improve the standard of science teaching and learning by encouraging the development of professional skills and providing appropriate materials.

The Physical Science component of the materials, in the form of topic boxes, worksheets and the new Teachers' Resource File, has evolved over the last decade. It has been well accepted and integrated into science teaching in many parts of the country. Wherever possible, practicing teachers are involved in the development and trialling of materials. The latter are always being modified by feedback from teachers in schools.

## BACKGROUND

In 1980 teachers began to ask for similar help with the biological component of the General Science syllabus for Stds. 6 and 7. SEP's response was to produce worksheets and eventually a teachers' kit. This was later discontinued for financial reasons but the worksheets themselves continued to be published and were used extensively. During 1985 we began to take a critical look at the kind of biology teaching that the worksheets were encouraging and asked ourselves 'Is this really our aim?'. Implementers reported that teachers were not using live specimens or their local environments in their teaching and some pupils were using the worksheets for revision. We were not encouraging the kind of pupil-centred practical work which is our aim.

Since January 1986 SEP has begun a thorough revision of its approach to biology teaching. This programme has become known, inevitably, as SEP-BEE (Apis Curriculumensis).

The history of curriculum innovation projects shows us that many of them fail to survive the rigours of the school and educational systems. Moodie (1987) has suggested that in order to stand the test of time an innovation should have

- an *analysis* of what was wrong with the subject teaching.
- a *theory* about what good teaching/learning in that subject should be.
- a *methodology* for that better teaching.

Let us now examine how SEP-BEE fares on these three criteria to start with.

### Analysis of what was wrong

This was based on observations by implementers on school visits and comments from subject advisors and teachers. In many cases Biology - the study of life - was 'textbookology' or 'worksheetology' (if I may coin the terms).

### A theory about what good biology teaching should be

In February 1986 a group of Natal biologists, teachers, lecturers and non-formal educators met at the University of Natal, at what subsequently became known as the Shepstone Workshop, to discuss this question. There was a high degree of consensus within the group. The main points raised were:

- It should be relevant to the child's experiences, future, careers etc.
- It should be taught to reflect positive value systems towards the natural world.
- It should have an ecological/conservation bias inducing positive attitudes towards the natural environment.
- It should stimulate curiosity and an awareness of the variety of living organisms.
- It should use local and living examples wherever applicable or possible.
- Biological skills, both cognitive and practical, should be developed in a self-discovery method.
- Biology teaching should be integrated with that of other subjects to provide an holistic approach to environmental awareness.
- Practical activities both inside and outside the classroom should be used to develop a strong foundation of biological concepts.
- Relationships between man and the subject matter and among the syllabus topics should be emphasized.

### A methodology for that better teaching

In April 1986 SEP implementers and friends met for a week, at what has become known as the Oakford Workshop, with Colin Wood-Robinson from the University of Leeds to look at recent trends on biological education and make decisions about the project's strategies in the light of that input (Keogh, 1986).

Wood-Robinson's input on recent trends in biological education may be summarized as follows:

| Traditional approach | Modern approach |
|---|---|
| Memorization of facts | Understanding of concepts and principles. |
| Type species of organisms | Student-centred, relevant biology. |
| Descriptive (drawing and dissection of the dead!) | Investigatory, problem-solving, numerical. |
| Students seen as empty vessels | Students seen as constructing knowledge. |
| Teacher as source of knowledge | Teacher as promoter or facilitator of learning. |

It was decided that:

1. SEP would adopt an investigative, activity-based, relevant and regionally-flexible approach to biology teaching which would have strong emphasis on

the development of environmental awareness and an understanding of the principles and concepts involved.

2. As biology teaching makes different demands on teachers to those of physical science (for example confidence in using live specimens and the natural environment) emphasis will be placed on in-service training and classroom contact to develop appropriate skills, particularly in the areas of questioning and pupil involvement.

3. The Biology worksheets in their present format do not encourage teachers to use live specimens or the school grounds as a basis for their lessons. They will therefore be discontinued.

4. They will be replaced by 'activity sheets' which will encourage pupils to use the information gained from their experiences and so to develop valid constructs.

5. The Teachers' Resource File will contain advice on planning and running biological phenomena.

6. Suggestions will be included in the Teachers' Resource File for non-biological activities such as role plays and simulations which can aid pupils' understanding of biological phenomena.

7. Some syllabus sections are not tied to the local environment e.g. microscopy and cells (Std. 7) and materials will be produced for these centrally.

8. Local relevance units will be produced where appropriate in the regions and accompanied by a process report on the development of the materials e.g. sugar cane ecology in Natal.

9. SEP will attempt to present information on local specimens and ecosystems to teachers in a readily accesible form. This will include the effective use of local learning resources such as museums, nature reserves etc.

10. SEP will hope to act as a channel through which teachers can share their own curriculum materials with colleagues throughout the country.

Moodie (1987) also suggests however that for survival the project would need:

- a set of materials which will support this methodology
- a mechanism to supply these materials
- a plan for training teachers to use these materials
- a decision about where to obtain people with suitable attitudes and skills as well as knowledge to do the training
- a plan for obtaining information from teachers (and others) on whether the project is having the desired effects.

This is the stage of development SEP-BEE has reached.

PUTTING SEP-BEE IN CONTEXT

In relation to the natural environment

The Shepstone Workshop indicated quite clearly the importance of responsibility towards the natural environment. Teaching 'positive value systems towards the natural environment' and 'ecological/conservation bias' were terms which emerged. If we were to ask the question 'Why do we teach Biology?' there could be many answers, particularly with reference to Std. 6 and 7 pupils where examination pressure and career choices are not significant. I would suggest an appropriate answer may be 'The development of Eco-literacy'. By this I mean an understanding of the workings of the natural environment and a feeling of responsibility towards it. The IUCN (1980) definition of conservation as 'The wise use of natural resources for the long term benefit of all mankind' could be our slogan.

People are unlikely however to adopt this attitude without an understanding of the natural environment's inner workings as well as an emotional attachment to it. Therein lies the challenge. Within the confines and restrictions of schools, syllabi and examinations, how do we achieve these high ideals? A tremendous challenge indeed.

The SEP organization is diverse, with branches in Ciskei, Transkei, Eastern and Western Cape, Johannesburg, Gazankulu and Natal/KwaZulu. Attempts are being made to forge links between the regions and other organizations and teachers. One of the stated objectives at the Oakford Workshop was to act as a channel through which curriculum materials could be shared between teachers. We must also remember that in the Southern African context many teachers are either totally untrained or untrained as science teachers (Gray, 1985). They are forced to teach the subject because there is no-one else to do it. In my own experience 'He did some science at school' is often quoted as a reason for being a science teacher in KwaZulu.

One must also consider the effects of the schools and education systems on any attempted innovation within them. The 'status quo' is safe, everyone knows what their roles are; there are no new scripts to learn. It takes courage and conviction to do something different.

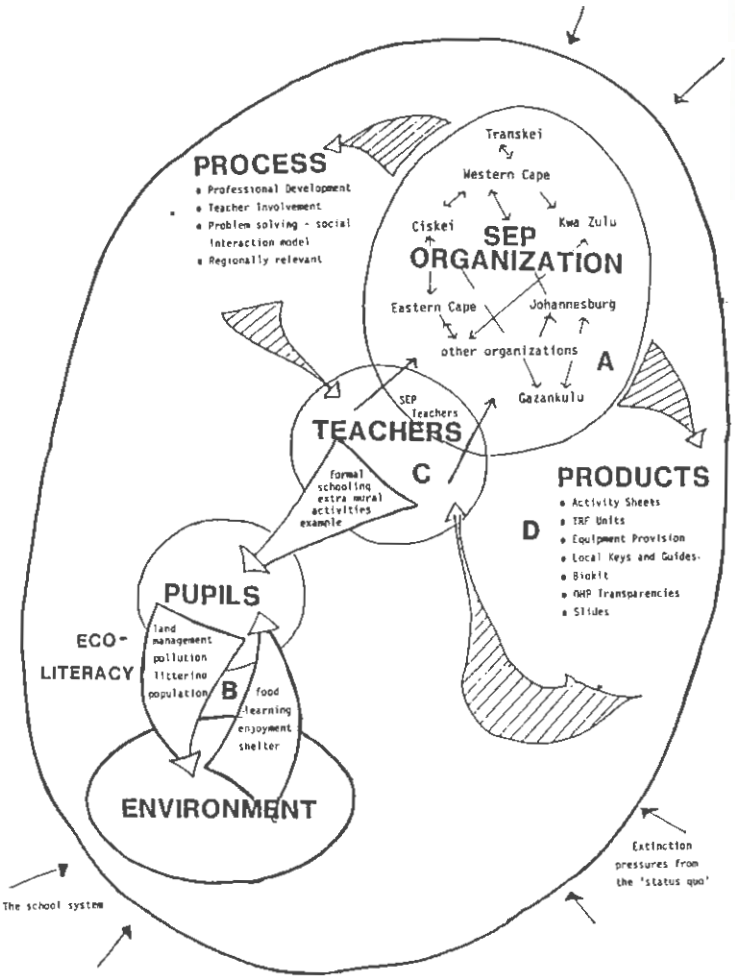


*FIGURE 1 The Anatomy, Physiology and Evolution of a new species - Apis curriculumensis.*

Figure 1 puts SEP-BEE into context. One may begin by considering the relationship between pupils, the public to be and the natural environment. On one hand the environment provides food, shelter and colthing as well as enjoyment, recreation, learning and potential understanding. The public in turn may impact on the natural environment through land management practices, pollution, littering and population control. The result of the effective manipulation of this relationship could be seen as the ecoliteracy mentioned above. Teachers may influence their pupils through their normal lessons, field trips and by the example they set. Some teachers are actively involved with SEP, others use the materials as they wish. The diagram also shows the equal emphasis which is placed on the *products* and the *process* by which they are produced.

In relation to curriculum development theory

Definitions of curriculum are almost as numerous and varied as the people who write about it. If I may add another one - hopefully to simplify rather than mystify - it is:

WHAT we teach i.e. CONTENT
HOW we teach it i.e. METHODOLOGY
WHY we teach it i.e. IDEOLOGY.

It is tempting and I think essential to want to look at what we are doing in the light of curriculum development models and to see what we can learn from them. Havelock (1971) suggested that there were three main models by which people use to disseminate knowledge.

1. Research Development and Diffusion

In this model the change comes about through a series of rational steps, starting with the initiator. This model regards the process of change as a rational series of activities in which innovation is discovered or invented then developed, produced and disseminated to the user. It is assumed that the products are 'value free' and that if they are good they will be accepted and used. The initiative of the model lies with the researcher, developers and disseminators while the receiver remains passive. Refer to Figure 2.

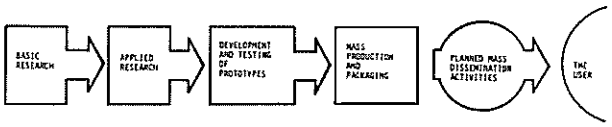


FIGURE 2 *Research Development and Diffusion Model (after: Havelock, 1971).*

Consumer needs may be implicit but do not appear to be the prime motivators for the generation of new knowledge. Research here is not concerned with specific human problems but rather a set of facts and theories that generated ideas for useful products which are turned into prototypes that are then tested. An example is the Nuffield Science Project, a high quality, well packaged and preserved professional pitch. This is also the predominant type of curriculum development in South African schools.

The innovator in such a programme must always ask whether the aims and objectives, stated or implied, are compatible with the school and whether the innovation is sufficiently congruent with the philosophy, practice and ability of the teachers who use it.

Many of the early, heavily funded, curriculum development programmes which followed this model have failed and attempts are now being made to modify this approach. The emphasis on thorough research into the problem situation and the development of appropriate materials seem vald. Experience has shown, however, that user involvement in the development of materials is very important for the eventual acceptance of the materials in the classroom. SEP and SEP-BEE have learned from this experience and see the research and development aspect as being very important. The biggest problem with the Research Development and Diffusion model appears to have been at the diffusion stage. SEP-BEE and many other projects are seeking to redress this situation by in-service training courses, teacher support programmes and teacher groups, such as the zone programme in Natal. It is intended that the strengths of valid research and appropriate development are incorporated into the programme through the activities of SEP's Research and Review Officer, teacher writing workshops and the development of a 'Biowatch group'. This will be a group of academic biologists whose function will be to advise on the validity of the content of the materials. Their input will then augment the classroom experience of teachers.

2. Social Interaction Model

The main concern of this model is the way in which innovations are spread. It assumes that any research and development has already been carried out and emphasises diffusion, the movement of messages from person to person and from system to system. In this model an innovation is brought to the attention of a potential receiver but it is the sender who determines both the receiver and the receiver's needs. The receivers' reaction determines subsequent stages. There follows a series of stages which culminate in acceptance or rejection of the innovation. The receiver moves through these stages by means of a process of social interaction with members of his group and so diffusion in this model depends greatly on channels of communication, personal contact and social relationship. See Figure 3.

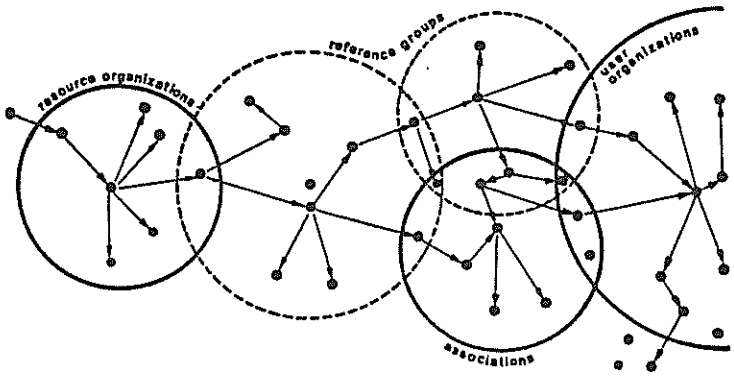


FIGURE 3 *Social Interaction Model (after: Havelock, 1971).*

This model is not appropriate for developing countries because the channels of communications are not sufficiently well developed. In many rural situations in Southern Africa teacher isolation is a real problem. In Natal/KwaZulu for example the development of zones and geographical areas in which teachers meet regularly for professional activities, are an attempt to overcome isolation and create channels of communication.

The high degree of acceptance which this model produces is unquestioned, but the teacher isolation which exists in many developing countries makes this form of curriculum dissemination unlikely notwithstanding its advantages. The zone system in KwaZulu, cluster schools in Soweto and teacher leaders in Transkei are some of SEP's attempts to overcome this and facilitate the kind of social interaction which helps to spread curriculum development.

3. Problem Solving Models

Here the user is seen as an active participant and

not as a passive receiver. In this model the need of the receiver, whether implied, stated or assumed, is the focal point. One may use the cycle format as illustrated in Figure 4.

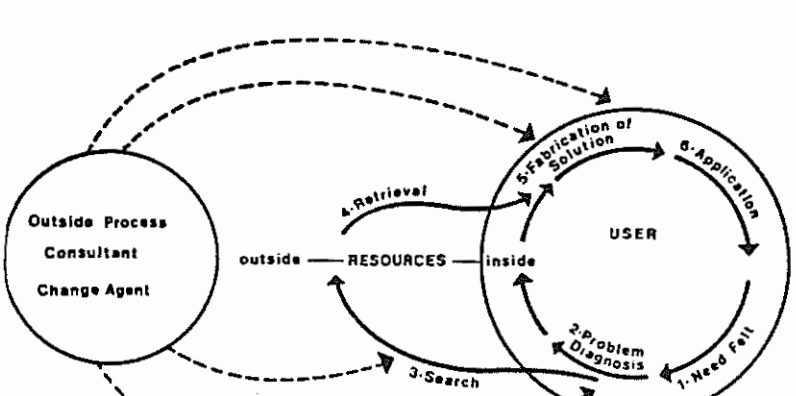


*FIGURE 4 Problem Solving Model (after: Havelock, 1971).*

One begins with a felt need articulated as a problem followed by a search for solutions. One solution is selected and applied. If the solution is the appropriate one it leads to a reduction of the original felt need. If it is inappropriate then the search resumes. The solution to the problem is undertaken by the receiver with the help of a change agent. This model has many advantages over others, for example the involvement of the receiver in the development of the solution ensures its 'ownership' and gives it a greater potential for survival within the system.

Later Havelock & Huberman (1977) developed a *Participatory Problem Solving model* (refer to Figure 5) which is something of a hybrid between the social interaction and problem solving models. It is based on the assumption that people have within themselves most, if not all, of the ideas, resources and energy to bring about change. The responsibility for analysing the need and diagnosing the problem lies with the user. The outside change agent may however assist with new ideas and specific innovations or by providing guidance on the process of problem solving at any of the stages in the cycle.

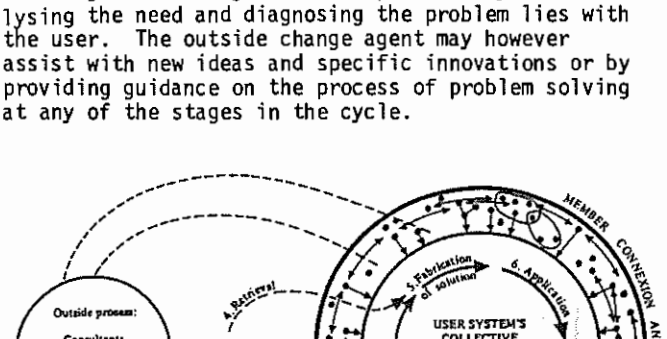


*FIGURE 5 Participatory Problem Solving Model (after: Havelock & Huberman, 1977).*

This model reflects many of the aspects of SEP-BEE's activities. The need was felt as early as 1980, expressed as a need for materials provided through SEP as a change agent, applied in the schools, evaluated and found in need of modification. The need was then re-expressed as: 'We need regionally relevant written materials and some form of biology kit' and so the search continues.

If we consider the models represented above, and look at how they relate to the way in which SEP-BEE seems to be developing, it appears to have elements of all of them. Perhaps it is most closely related to the Participatory Problem Solving model. The following points serve to support this opinion.

a. The Research Development and Diffusion model is reflected in the importance that SEP and SEP-BEE give to thorough research into the situations in which teachers are working and the validity of the content of the curriculum materials which are presented to users.

b. If we consider the Social Interaction model we must accept its problems in developing countries and rural areas. SEP-BEE's attempts to overcome this include regular meetings of members, contact with other organizations such as the Natal Biology Teachers Association, the Natal Parks Board, Umgeni Valley Environmental Education Centre and the National Botanical Gardens.

c. The belief that teachers are the most important people in curriculum development and that groups of teachers are capable of producing solutions to their own problems is reflected in SEP-BEE's programme of interest groups (worksheets, overhead transparencies, local learning resources etc.). The products of the research of these groups are beginning to be felt. The mechanism by which the information and skills are transmitted to other teachers is still evolving. It involves utilizing the existing structures of teacher meetings, a newsletter and workshops. It is being evaluated continually with the aim of producing a better system within which acquired knowledge and skills can be disseminated *to* teachers *by* teachers.

## CONCLUSION

Curriculum innovation is a two-edged sword. Innovation is a painful process: it requires the teacher to take risks and have commitment to the 'new script' for his classroom activity; it will not necessarily gain him approval from his superiors or better examination results; the pupils often expect to be told the answers etc. The list of 'cons' is long. The 'pros' are sometimes harder to find; for example the satisfaction of a job well done, the conviction that you are giving your learners the best possible provision for their future and, in this case, the development of a high level of ecoliteracy. There are also the rewards of working with a like-minded group of people and the belief that one is doing something worthwhile.

To round off, I read recently that curriculum development is the ideal area for the application of Murphy's Law ...

> It is always more difficult than you think,
> It will always take longer than you think,
> It will always cost more than you think,

and still we do it!

MAKES YOU THINK, DOESN'T IT!

## REFERENCES

GRAY B. 1985: Teacher Development Programmes in an African context - Principles for effective Implementation. *Education Faculty Journal.* University of Natal.

HAVELOCK R.G. 1971: *Planning for Innovation.* Institute for Social Research, University of Michigan. Ann Arbour.

HAVELOCK R.G. & HUBERMAN A.M. 1977: *Solving Educational Problems: The theory and reality of innovation in developing countries.* Unesco. Paris.

*Continued on p.35*