STUDENT-CENTRED EVALUATION OF DISTANCE EDUCATION COURSE MATERIAL IN SCIENCE IN SOUTH AFRICA

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The rationale

If the quality of distance education course material is questionable, or the course support mechanisms insufficient, many students probably will not get through their examinations and will have to repeat their courses. Much of the course material at present generated in South Africa for open and distance learning seems to be inappropriate for the target group for which it is intended. This is undoubtedly an important contributory factor to the high failure rates in tertiary education, particularly amongst second language speakers of English.

Even when the content of such course material is acceptable, it seems that some academics in South Africa, prefer a complex, high-flown style to a more straight-forward one. They are not alone. A study amongst a group of language specialists based in Brunei made a few years ago showed that this group of academics valued journals in their subject which contained complex academic language above those written in a more direct style (Sharp, A, 1991, *IATEFL Newsletter* No. 112). Why is it that some academics, wittingly or unwittingly, tend to write above the heads of their students? Should we not be asking our readers how they feel about our writing?

The matter of the accessibility of South African distance education course material, in other words the extent to which the text and illustrations are understood by the reader, needs to be scientifically investigated. We have to work towards developing guidelines for our South African writers, particularly those operating in the field of distance education, where the printed page counts for so much. Furthermore, such guidelines should be grounded in thoroughly researched design principles, based upon research carried out in South Africa. Some of these principles may already be known and widely used, in which case the study may confirm their validity. Others might emerge which are particularly suited to our students and which will facilitate their learning.

The research questions

In what ways is course material in the biological sciences inaccessible to the reader? Which aspects or features of such course material are difficult for second language speakers of English to understand? To what extent do students' ideas about improving their course material correlate with accepted principles of design? Are writers of course material in the biological sciences always aware of the difficulties experienced by their readers? These are some of the research questions which need to be addressed.

Theoretical framework for the study

The theoretical framework for the present study is an attempt to link the acceptability of course material in Microbiology and Zoology, written in English, to its comprehensibility and ultimate learnability for second language speakers of English. Hence the overall study seeks to encompass and relate to one another three distinct fields of research; on the one hand the contribution of typography, including page layout, to language accessibility, (Waller, 1992, Hartley, 1994 et al); the interactive theory of reading, (Silberstein, 1987, Smith, 1971, Carrell, 1983 and 1988, Grabe, 1991 et al) and the conditions required for deep, as opposed to surface, learning, (Marton, Hounsell and Entwistle, 1984, Entwistle and Ramsden, 1983, et al).

Given these three distinct, though closely related, facets of readability, the central focus of the study is the comprehensibility of English medium course material in Biology for second language speakers of English who are based in southern Africa. These students' understanding of the text and illustrations will depend on a number of factors such as their cultural background, their existing knowledge of the biological sciences

and their language proficiency. It will also depend on the course material writers' sensitivity to these factors and the extent to which adjustments in typography, language, layout and design are made to meet the readers' specific needs.

Interactive reading

Text does not carry meaning by itself, but can only provide direction for its readers as to how they should retrieve or construct meaning from their background knowledge. Such knowledge structures are known as schemata. So comprehending a text is an interactive process between the reader's background knowledge and the text. Efficient comprehension requires the ability to relate the textual material to one's own knowledge (Carrell, 1983:557). Thus the most efficient kind of reading is interactive, involving both bottom up and top down processing. According to Macdonald (1990:58-61) bottom-up processing focuses on the rapid and accurate identification of lexical and grammatical forms whilst top- down processing places the emphasis on meaning and is conceptually driven. Examples in Microbiology of top-down processing, making use of hierarchically arranged schemata, would be when the reader ascertains that a text is about fungi, which leads to the expectation of finding information about both harmful and non-harmful (including edible) fungi. If readers have the right kind of schemata in place, they are better placed to understand whatever follows in the text.

Bottom up processing, which occurs when the text is made sense of word by word and phrase by phrase, is the complimentary process to top-down processing. It can be a very slow one for second language speakers of English. Cues are not always identified which might help the student guess at what is coming next. Schemata cannot be constructed by the readers on the basis of insufficient clues. Such insufficiency can arise because they lack the requisite vocabulary, a common problem with second language readers. Failure to activate an appropriate schema when reading will result in a lack of comprehension. This could be due either to the writer's not having provided enough clues in the text for the reader to effectively utilize a bottom-up processing mode to activate the schemata, or it may be due to the reader's not possessing the appropriate schema anticipated by the author which, again, will lead to lack of comprehension (Carrell, 1983:560).

Deep and surface learning

Entwistle and Ramsden (1983:14) have observed in students a fundamental distinction between deep and surface learning:
Some students adopted a deep approach. They started with the intention of understanding the meaning of the article, interacted activities with the author's arguments (relating them to previous knowledge and their own experience) and tried to see to what extent the author's conclusions were justified by the evidence present.

Other students seemed to rely almost exclusively on a surface approach. Their intent was to memorize the parts of the information they considered to be important, guided by the type of questions they anticipated being asked subsequently. (Entwistle and Ramsden, 1983:16-17).

A direct link can be drawn between the notion of deep and surface learning and the schema theory of reading which posits that readers' understanding of what is read will be enhanced if they already have a schema or framework of knowledge of the topic being discussed. For example if a student has acquired a schema for anthozoans, the study of corals and sea anemones will be placed in this context, provided sufficient clues and signposting are given in the text. If course material writers use all means at their disposal, including providing sufficient background information and making use of soundly tried writing principles, this should lead to a process of deep learning in the student. If these principles are not applied, it is unlikely that deep learning will take place, the student will not fully understand what is being studied and will be reduced to memorizing in a mechanical way, which amounts to surface learning.

Research design and research method

Research design

The naturalistic or constructivist research design has been used for data collection. Here it is essential that

the study be carried out in the same time and context, in other words the same frame of reference, that the inquirer seeks to understand (Guba and Lincoln, 1990:175). The interviews with staff and students have been conducted in an informal manner and a friendly atmosphere has been created in a non-threatening setting. A more quantitative approach, making use only of questionnaires, would have produced infinitely less rich data.

Research methods

Selected students and all the staff in the Biology Department on the Vista University Distance Education Campus (VUDEC) have been interviewed. In line with the naturalistic method, sampling of data has taken place serially, with no sample element being chosen until after data collection from the preceding element had already been largely accomplished. There was a continuous interplay of data collection and analysis taking place as the enquiry proceeded. As I interviewed the first respondent, or made a first observation, I attempted to uncover items of information gleaned from the interview transcripts that appeared to be relevant to the study's focus. Each interview was followed immediately by a data analysis using the method known as constant comparison. What has emerged has been a more and more inclusive construction, which takes account of the inputs from each and every one of the respondents. Consensus has been the ultimate goal and was very often achieved.

The interviews

Reason for choosing the interview mode

The study begins with the perspective of the student, because it is believed that this is the only meaningful way of ascertaining the impact and effectiveness of existing course material. Members of the academic staff who write the course material have also been interviewed and the problems and issues thrown up by the student interviews made known to these writers. Guba (1990:11) sees “evaluation outcomes” as meaningful constructions that individuals or groups create to make sense of situations. For Guba findings are not facts, but the creations of an interaction process that includes evaluator as well as the other stakeholders.

According to the naturalistic method, evaluation must have an action-orientation that defines a course to be followed, stimulates involved stakeholders and generates and preserves their commitment. All the stakeholders in the project knew where they were going in discussion: the creation of improved course material, based on principles yet to be confirmed. I have used the “responsible focusing” technique; determining what questions are to be asked, based upon stakeholder inputs, and moving towards joint constructions through gradual consensus.

Interview format

In 1996 I interviewed six Vista University Distance Education Campus students a total of three times, transcribing these interactions as I went along and referring back to them in subsequent interviews. The first interview was with one student, the second with two and the third with three or four. After an initial discussion on the students’ backgrounds and aspirations, I began to focus on samples of their original and revised course material, the former of which had been taken from their study manuals and reworked in collaboration with the Biology Department course material writers. This interview model was used again with the ten main study students in 1997, where a fourth interview and a standardized language test were introduced.

In this year also I extended the informal discussions of 1996 held with members of the Biology Department at VUDEC to interviewing them in a more semi-structured way. My aim was to ascertain their perceptions of writing expository texts and of teaching Biology to second language speakers of English.

Language and schooling

School and college experiences for all the students interviewed meant studying Biology through the medium of either English or Afrikaans; and sometimes through each in turn. Occasionally code switching

was allowed in class between the language of instruction and the mother tongue, especially when a vernacular-speaking teacher was in charge. This helped to elucidate difficult concepts. At college level, however, it was more often the case that an Afrikaans-speaking lecturer, with poor mastery of English, would revert to his or her own mother tongue in class, leaving the black students dumbfounded. Those students who had had extensive tuition in Afrikaans at school were in a more fortunate position. One of the respondents described how she had learnt Biology through the medium of Afrikaans at primary school and through the medium of English at high school. Another spoke of being taught Biology at college in English, and Agricultural Science in Afrikaans! She found this very confusing.
The key to success in Biology usually lay with the Biology teacher. Poor teachers caused, or nearly caused, students to drop out; good ones inspired the students and encouraged them to succeed.

Students' backgrounds

All the students interviewed expressed a deep love of the subject as the main reason for choosing Biology. This was coupled with a burning desire to improve their teaching techniques and thereby enrich the learning of their pupils. Several of the primary school teachers expressed the hope that gaining the desired teaching qualification would enable them to obtain a teaching post in a high school. However earning more money nowhere featured high on their list of priorities. A younger male respondent confided that passing Biology would enhance his status!

Most of the students indicated that they had experienced a lot of difficulty in studying and holding down a job at the same time. This was principally because of a severe shortage of time to devote to their studies due to work, family, community and social commitments. Traditionally African women are expected to do all the domestic chores in the home such as the cooking, shopping and cleaning, irrespective of whether or not they are working, let alone studying part-time as well. If the student is a divorcee with small children, the burden becomes even greater.

Strategies which the students employed to overcome some of the above restrictions could take the form of rising very early in the morning in order to give time to their studies when the mind is fresh and the house quiet; some would take study material wherever they went so as to utilize the moments between other duties. Many township schools in South Africa run on a dual shift system to accommodate large pupil volumes. One of the respondents teaching in such a school would study at home when working the late shift, or at school after finishing the early one. Another said she made use of her classroom for study purposes over the weekends. One of the male students recorded his own tapes of difficult sections of the work; others hurried to complete their marking at school to make more time for studying at home. Conditions in the townships, where most of the students interviewed live, are not very conducive to learning. Radios are played loudly, homes are crowded, crime is rampant and police protection scarce. One woman described how she places a blanket over her window at night, so as not to be noticed by passers-by. Another uses the bathroom for studying as the only safe haven from her children!

Examination of extracts from the course material

The second, and third interviews - and the fourth interview also for the main study students - consisted of discussions focused on extracts taken from the more problematic topics in the Zoology and Microbiology sections of the course. Both the original and restructured versions of these extracts were considered, each in turn. The kinds of issues which continually arose were that the students have difficulty with many of the general academic words and phrases, as well as with the scientific terminology used, both in the text and in the diagrams. Examples of these, which proved to be stumbling blocks in the extract on corals, (see also Appendix 1) are:

anthozoans, polyps, colonial, substructure, skeleton, coral reef, radiating ridges, projecting hardly at all, lateral sheet of tissue, connecting tissue, living tissue, solitary, calcium carbonate skeleton, pharynx, tentacle, basal plate, cup-like indentation

Extract C, taken from the Microbiology section of the course, proved equally confusing, with the following words or phrases, (See also Appendix 2) giving problems:

pathogens, Claviceps purpurea, sclerotium, LSD, Ergotism, toxic alkaloids, locker rooms, micro-organisms, mycelium, hallucinogenic, damping-off, rusts, smuts, St Anthony's Fire, locker rooms

The comments which students made about these words or phrases were telling. The students used excellent reading strategies to interpret unknown noun phrases, such as "locker rooms", but were nevertheless often provided with too few clues to enable them to come near to the true meaning. (See Appendix 3.) Without exception the students said that they wanted glossary explanations in their manuals, either at the beginning, or at the end, within chapters, in the text itself, or as footnotes at the bottom of the page. Two of the students asked for separate glossaries in booklet form. Cooper (1995) has shown a direct correlation between a student's level of academic performance and vocabulary proficiency. On the basis of this evidence it would seem that adequate in-text explanations, as well as the provision of glossaries, are essential features when writing for science.

Generally speaking the students preferred the revised Extracts B and D to the originals, (see Appendices 1 and 2) although the revised versions still had shortcomings which needed to be addressed. None of the respondents was concerned about the revised versions being longer than the originals. Clearly these students would much rather read something once and understand it completely than ten times and still find themselves in the dark.

It is also essential that we learn as much as possible about the cultural background of our readers. Such a procedure is particularly important for a subject like Biology where traditional beliefs often clash, head on, with scientific knowledge. Even traditions can contradict each other, it seems. Several students described a plant which is said to deter snakes; others spoke of a plant which is believed to attract them! Two respondents recounted beliefs that a particular plant which is kept in the home will bring conflict and unhappiness to those dwelling there. One student recounted a cautionary tale for young girls entering puberty who were warned against eating eggs and peanuts. There was even a story about newly-capped graduates being imbued with supernatural powers!

Whilst some of the students interviewed seriously questioned such traditional beliefs; there are others who are still on the threshold between believing and discounting them. Course material writers are advised to take cognisance of the cultural perspective in their writing and to ease those of their readers who need it over this threshold and into the modern world. Equally, such writers should be at pains to fully explain all Western cultural and historic references such as "St Anthony's Fire" (See Appendix 2).

The anticipated outcomes

The most important anticipated outcome of this study is the discovery of new and affirmation of some established design principles for use by writers in the biological sciences. Another anticipated outcome is an enhanced ability by these course material writers to generate more accessible instructional discourse. The third important anticipated outcome is an increase in the level of learners' comprehension and enjoyment of their course material in Biology, leading to success in their examinations and a broader perspective on the world of science.

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Appendix 1

EXTRACT A

Corals

The most -spectacular and biologically important anthozoans are the hard corals, which sometimes form continued coral reefs. Although some corals are solitary, most are colonial and they all secrete a hard skeleton of calcium carbonate. The corals are composed of a limestone base overlaid by a thin layer of tissue and interconnected living polyps. Each polyp is sunken into a cup in this skeleton. In addition the skeleton projects upwards as radiating ridges into the base of each polyp. As long as the colony is alive, calcium carbonate is deposited beneath the living tissue. The skeleton provides a substratum for attachment and projection, as each polyp can contract into its cup, projecting hardly at all above the edge of the cup.

EXTRACT B

The Hard Corals

Where do the hard corals belong?

The hard corals are members of the anthozoans, which also include the soft corals and the sea anemones. The hard corals are probably the most impressive and biologically important members of the anthozoans, which in turn form a branch of the phylum Coelenterata (Cnidaria). Although some of the hard corals are solitary, living independently of one another, most of them are colonial*, being linked together to form continuous coral reefs.

Why are they called hard corals?

Hard corals are so named because, whether solitary or colonial, they all secrete a substance consisting of calcium carbonate which hardens into a skeleton of limestone. The colonial hard corals have a thin layer of living tissue which covers their communal skeleton and connects each living polyp, or coral animal, to its neighbour.

How does the skeleton assist the polyps?

The skeleton has cup-shaped holes or indentations, each of which has in it a polyp. The skeleton acts as a base or substratum which anchors each polyp in its cup and from which it can project in order to feed. The polyp can contract again into its cup when danger threatens. In addition to indentations, the hard coral skeleton also has ridges which fan out from a central point at the base of each polyp, like spokes in a bicycle wheel. Whilst the colony lives, each polyp deposits calcium carbonate continuously beneath its own living tissue.

* A colony is a group of individuals of the same species living together, whose member are sometimes linked by living tissue. (Taken from Henderson's Dictionary of Biological terms.)

Appendix 2

EXTRACT C

HARMFUL FUNGI

Pathogens

Many fungi cause great economic losses, as pathogens cause diseases in crop plants, agricultural animals and man. Plant diseases like spots, rusts, smuts, mildews, cancers, rots, wilts and damping-off are caused by fungi. Some of these plant diseases are passed on to man when the diseased plants are eaten, e g the ergot disease in grains caused by *Claviceps purpurea*.

The genus *Claviceps* are parasites on grass species and grain. A sclerotium, which is a resting winter stage of some fungi when they become a mass of hardened mycelium, is formed. The sclerotium contains toxic alkaloids like LSD. When eaten by man, it can cause blindness, convulsions, illusions and paralysis. In the middle ages this disease was known as 'St Anthony's Fire' or 'Holy Fire', because of the horrible symptoms. Ergotism, however, is much more common in domestic animals. Cattle grazing in infected fields are regularly poisoned by the sclerotia of this fungus.

Athlete's foot can be picked up from the damp floors of locker rooms. A fungus *(Tinea pedis)* attacks the skin between and under the toes, causing itching, cracking and blisters. To prevent athlete's foot, make sure that your shoes permit air to circulate so that moisture cannot become trapped inside them. After you bath, you should always take care to dry your feet thoroughly, and apply a fungus-killing powder.

EXTRACT D
HARMFUL FUNGI

What are pathogens?

Pathogens are micro-organisms that cause disease. Harmful fungi are therefore also classified as pathogens. Many of the pathogenic fungi cause diseases in crop plants, others in plants and agricultural animals, such as cows and sheep and in humans. There are also pathogenic fungi which are specific to humans. All of these diseases can lead to considerable economic loss. Let us study some of them more closely.

Diseases which attack plants

Plant diseases like spots, rusts, smuts, mildews, cancers, rots, wilts and damping-off are all caused by harmful fungi. *Plasmopara viticola*, for instance, causes downy mildew in grapevines. Smuts is another name for the smut fungi, a group of pathogens which attack important crops, leaving black dusty areas which resemble smuts or soot. The rust fungi, known as rusts, are another group of pathogens which infect crops. Then there are the cancers which are attracted specifically to plants..

Diseases which attack plants, animals and humans

Members of the genus *Claviceps* are parasites on grass species and grain. In such parasitic fungi, during the resting winter months, a mass of hard mycelium is formed and this we call the sclerotium*. Ergot disease, or ergotism, which occurs in grain and is caused by *Claviceps purpurea*, is passed on to human beings when the diseased grain is eaten. However ergotism occurs more frequently in agricultural animals than in people. This is because cattle grazing in infected fields are more likely to come into contact with and be poisoned by the sclerotia of *Claviceps purpurea* than are people.

When *Claviceps purpurea* is eaten by human beings they can become very seriously infected, sometimes with fatal results. The reason is that the sclerotium contains toxic alkaloids like LSD (lyseric acid diethylamide) a powerful hallucinogenic drug. When people eat LSD they can be permanently blinded, have convulsions, suffer from illusions and become paralysed. Because of these extreme symptoms, ergotism has been regarded with fear and superstition for many centuries. During the Middle Ages it was regarded as a religious curse and known as 'St Anthony's Fire' or 'Holy Fire'.

3. Diseases which attack humans

Athlete's foot is an example of a disease which attacks human beings. It can be contracted from the damp floors of locker rooms in sports complexes, factories or schools where the washing and changing facilities are shared. This disease is caused by a fungus called *Tinea pedis*, which attacks the skin between and under the toes, causing itching, cracking and blistering.

How can I guard against catching Athletes' Foot?

Here are two useful tips which will prevent you from contracting Athlete's foot:

Make sure that your shoes allow air to circulate. In this way moisture will not become trapped inside them and any *Tinea pedis* present will be unable to cause Athlete's foot.

After you have taken a bath or shower, always dry your feet thoroughly. Then dust them with a fungus-killing powder which will destroy any trace of *Tinea pedis* that might have settled on them.

* A sclerotium is a firm, often rounded, mass of hyphae with or without the addition of host tissue or soil. Normally there are no spores in or on it. The sclerotium produces a fruit body or mycelium.

Appendix 3

VERBATIM QUOTATIONS FROM INTERVIEWS WITH STUDENTS

EXTRACT A : CORALS

"The skeleton provides a substratum for attachment and projection, as each polyp can contract into its cup, projecting hardly at all above the edge of the cup.

Student A: Here I do not understand what they mean by "above". Do they mean "the above information" or above which edge? That "above" here confuses me.

Student B: I don't know whether they mean that whole polyps project out or that they usually project half.

"The corals are composed of a limestone base overlaid by a thin layer of tissue and interconnected living polyps".

Student A: I think the sentence is too long and is somewhat confused. I think it should be further expounded.

Student B: Surely I'm not happy about it, because here, the concept I have, or the idea I have, as you look into the corals that link to each other, are, they are interconnected by each other through a limestone. That's the concept I have.

"The most spectacular and biologically important anthozoans are the hard corals, which sometimes form continued coral reefs."

Student A: How do they come to the anthozoans? You'd like a little review to remind you of them.

Student B: I didn't have the idea of remembering them. So to me, first to be clearly framed, the author must make this clear to the students. The students must not struggle to get the meaning.

"Each polyp is sunken into a cup in this skeleton. In addition the skeleton projects upwards as radiating ridges into the base of each polyp."

Student A: I think it means it moves. If the skeleton projects upwards, it means it is in motion.

Student B: I think it is something to do with heat from the sun.

EXTRACT C: HARMFUL FUNGI

"In the middle ages this disease was known as 'St Anthony's Fire' or 'Holy Fire', because of the horrible symptoms."

Student A: I wanted to know why Anthony was involved.

Student B: Which disease? I don't know which disease they are referring to.

"Some of these plant diseases are passed on to man when the diseased plants are eaten, e.g. the ergot disease in grains caused by Claviceps purpurea."

Student A: He could have given us another name, because this is a scientific name. I'm from a Tswana -speaking family; he's from a Tsonga; that other one from a Pedi. And then we have our African names for this particular thing.

Student B: What kind of a disease? The traditional name or explain it in a simple language.

"The sclerotium contains toxic alkaloids like LSD."

Student A: They mustn't use the acronym. They must at least write it in full.

Student B: Actually they must explain what LSD is.

"Athlete's foot can be picked up from the damp floors of locker rooms."

Student A: Rooms that are locked. Maybe it's no longer being used.

Student B: Rooms that are not exposed sort of to air and so forth, that are locked most of the time.