TEACHING READING IN EFL WITH PARTICULAR REFERENCE TO ENGLISH FOR SCIENCE AND TECHNOLOGY

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Reading has always been the most important skill in EFL programs at the college level in Taiwan. Students in science and technology almost exclusively use textbooks in English published in the United States or in the United Kingdom. Their laboratory manuals and even experimental reports are also in English. English, as a result, has become their tool for studying and work at school, even though they encounter difficult problems in understanding their texts and carrying out their laboratory work. Without a utilitarian program in EFL in their freshman year to equip them with good reading ability in English, they cannot become efficient readers even if they double their efforts in their studying in a specialized field. However, in the light of illuminating findings in teaching reading in EFL and research in English for Special Purposes, especially in English for Science and Technology, much can be done to improve EFL programs at the college level in Taiwan. Therefore, the main purpose of this short paper is to evaluate techniques in teaching reading in EFL and principles for preparing reading materials for English for Science and Technology.

Reading in EFL can be categoriged into reading for language and reading for ideas (Saville-Troike, 1973). Readning for language as practiced in the audio-lingual method serves merely as reinforcement for orally introduced structures and vocabulary which might be good for beginners but it cannot meet the need of advanced students who have had at least six years of EFL training at junior and senior high schools. For these advanced students, they need training in reading for ideas.

Then, what is reading? For a long period of time, Thorndike's theory that *reading* is reasoning has been accepted by researchers and authors of teaching materials for reading (Otto, 1971). Wardhaugh's definition of reading as the visual recognition of graphic symbols and an understanding of their meaning may be understandable to laymen and may sound logical at this stage of our study. The following is quoted from Wardhaugh (1969):

> When a person reads a text, he is attempting to discover the meaning of what he is reading by seeing the visual clues of spelling, his knowledge of probabilities of occurrence, his contextual-pragmatic knowledge, and his syntactic and semantic competence to give a meaningful interpretation to the text. Reading is not a passive process, in which a reader takes something out of the text without any effort or merely recognizes what is on the page and then interpret it, a process in which a stage of decoding precedes a stage of involvement with meaning. There is little reason to suppose that there are two such discrete, non-overlapping stages. Reading is instead an active process, in which the reader must make an active contribution by drawing upon and using concurrently various abilities that he has acquired.

A more recent schema-theoretic view of reading holds that spoken or written text does not carry meaning (Adams and Collins, 1978). Rather, a text only provides directions for listeners or readers as to how they should retrieve or construct the intended meaning from their own previously acquired knowledge. The words of a text evoke in

the reader associated concepts, their past interrelationships and their potential interrelationships and the organization of the text helps the reader to select among these conceptual complexes. Each schema, which is a description of particular class of concepts and is composed of a hierarchy of schemata embedded within schemata, at each level in the hierarchy consists of descriptions of the important components of its meaning and their interrelationships. Because the schema specifies the interrelationships between its underlying components, once any element is specified, it can be understood in the proper context.

A crucial idea for a schema-theoretic account of reading comprehension is that it involves the coordinated activity of schemata at all levels of analyses. As schemata at the lower levels are activated, they are bound to and thus evoke schemata at the next, higher level; as these schemata are activated, they in turn trigger their own superordinate schemata until the input data are automatically propagated up the hierarchy toward more meaningful levels of representation.

Research in schematic view of reading has been active in recent years. In a research report in 1981 (Reynolds et al. 1981), it shows that cultural schemata can influence how prose material is interpreted. In another study (Brewer and Lichtenstein, 1980), it is suggested that there are important theoretical differences between schemata for events, schemata for narratives and schemata for stories. All these recent studies have pointed out new directions in reading research and implications for reading material preparation. But so far they are too sketchy to be applicable to reading in ESL/EFL. Therefore, I will return to the more conventional view of reading, especially the tested theory and its applicable techniques.

A widely applied theory of reading which is constantly and fruitfully applied to reading in ESL is the one that was proposed by Kenneth S. Goodman (O'Neill and Qazi, 1981). Reading, according to Goodman, is a "psychological guessing game." Efficient readers do not laboriously read word-by-word; rather, they utilize the redundancy of language and their knowledge of semantic, syntactic and discourse constraints inherent in the language to predict structures. Along the same line of view held by Wardhaugh, Goodman also regards reading as a decoding process, in which readers predict structures, sample them against the cumulative semantic context which builds in readers' minds, and then confirm or disconfirm the hypotheses which readers have formed. This process allows readers to greatly increase their speed and comprehension. In contrast to this reading process, it can be easily found that EFL readers, including many college students in Taiwan, focus on the word rather than on the entire text. They are tied to the dictionary and expect to understand everything in the text. On the contrary, they know the word but not the meaning in the sentence or in the text. Under such circumstances, the best strategy in accordance with the reading process is to teach students to use information from the graphemic, semantic, syntactic, and rhetorical information to get meaning from print.

In the advanced ESL/EFL program, vocabulary is usually not a main problem in reading. Vocabulary will be discussed more in detail in the second part of this paper devoted to the analysis of EST. Yet, as far as reading in general is concerned, students should be taught to use their knowledge of word derivations, synonyms, and especially their ability to guess the meaning of a word from its context. In order to read effectively, students should know that it is not necessary to cling to a word when its meaning is

not totally clear.

To teach students to look beyond the word to the sentence, paragraph and the entire text is important. A good way to change students' strategy not to focus on the word as the unit of meaning is to have them read a passage with words missing (Kalnitz and Judd, 1981). In this way, students will discover that they are able to understand the meaning of the passage. Another way of achieving this is to have them do a recall exercise. Students read a passage without the help of a dictionary, then close their books and write down everything they remember. Students will be able to cover the main ideas of the passage they read although they may miss some of the details. These kinds of exercises will help to change their concept of what is important in reading.

After students know that they can read on without depending on the dictionary, we have to teach them skills that will help them to guess the general meaning of the word. These skills used by Kalnitz and Judd fall into three categories:

1. determining the part of speech of the unknown word
2. using context clues to guess the meaning of the word
3. using morphological clues to guess meaning.

Students need to be aware of clues that will help them to determine the part of speech of the unknown word as this will help them to limit the range of their guessing. They need to be taught a sensitivity to the clues that are present. They must also be taught to look not only at the word itself, not only at the surrounding words, but at the entire sentence, paragraph and text for clues. Grammatical markers and syntactic clues are two types of clues that can help students determine the part of speech of an unknown word. Nouns, verbs, adjectives and adverbs can be identified by these clues in terms of their parts of speech.

It is now generally realized by linguists and reading specialists that the spoken and written languages are not the same. Wardhaugh (1969) believes that any kind of writing involves a certain amount of "editing". Writing is not just speech written down. As a matter of fact, many syntactic devices are used in writing. As a result, syntactic meaning is important in reading. By using analytic syntax, Ruth Berman (1975) broke down her technique for advanced level reading into title, nominalization, reduced relative clauses, pronominal reference, sentence connectors, whether X or Y, negation, and punctuation. Title indiates the theme of what students are going to read. The title often uses key-words which recur in the text and hence are important to general understanding. In Berman's view, an abundance of abstract nominals which are very often of Romance origin and with some degree of morphological complexity tends to impede understanding when compared with the more concrete forms of verbs. Reduced relative clauses refer to a clause in which the relative pronoun and the auxiliary are omitted, such as "the activities connected with he production of food". Pronominal reference is the relation of pronouns to their relevant antecedents. Sentence connectors are the single words or phrases used to connect other ideas, such as *furthermore, thus, however,* Berman found that "whether . . . or not" and "neight . . . nor" were difficult for her students to understand in their reading.

In the breakdown of her technique, Berman listed two kinds of rhetorical or cohesive devices: connectors and pronominal reference. The publication of Halliday and Hasan's *Cohesion in English* (1976) marked a milestone in discourse analysis in its connection with reading. In Halliday and Hasan's term, cohesion refers specifically to non-

structural text forming relations which are semantic relations and the text is a semantic unit. Halliday and Hasan listed and analyzed different types of reference which are essential to a complete understanding of text in reading. Of particular importance are substitution and ellipsis which usually cause misunderstanding among ESL/EFL readers. The types of conjunction explained by these two authors are also very useful to students reading English as a second or foreign language because they have never been lucidly treated before.

Having done a brief review of clues in the reading process, we can now proceed to the total process of reading for meaning or reading for ideas. Mary Eleanor Pierce (1975) used formal redundancy to teach reading for ideas. Basically, she treated ideas as thoughts and an idea in writing is presented in a general statement supported by statements giving the facts. An idea also shows what the author thinks about a situation. A supporting statement may contain a comment about a particular fact or may contain a comment about the idea.

Pierce (1975) also utilized redundancy in the paragraph environment to find clues in reading. In this method, students may be taught to find the topic sentence in a paragraph and regard other sentences in the paragraph as information that support the topic in the paragraph. As ideas are expressed in topics, readers have to look for relationships. Since the topics within a theme all support the theme, they are related to each other in a general way.

As far as text is concerned, the use of generalizations supported by examples in expository prose should be taught as an important rhetorical device of English. ESL/EFL readers should be taught how to recognize and identify generalizations and distinguish them from examples. Kalnitz and Judd (1981) introduced the concepts of generalization and example and taught the vocabulary peculiar to each (in general, on the whole, always, never, vs., for example, for instance). They first asked students to identify the generalization in a paragraph and then asked them to identify the examples. In Kalnitz an Judd's article, critical reading skills are suggested. Students can be taught to determine whether or not the examples given actually support the generalization. In the process, students can make use of the concept as a means of identifying the main idea, and in locating topic sentences.

Students can become better readers if we let them talk about or write down what they read. A general practice in a reading class is to do comprehension exercises. As we are teaching reading for main ideas, we should ask questions about main ideas of reading selections and avoid questions about details. If questions focus on minute, non-essential details, we may give students an impression that every word on the page is equally important and deserves attention.

Cultures and languages organize in a different ways. As Kaplan points out the circular pattern of exposition in Chinese is different from linear organization in English, students need to be exposed to the styles of English rhethoric in order to understand what they read.

Advanced students in ESL/EFL need two tools for maximally efficient reading: skimming and scanning. Unless they have developed this kind of skills they can never be on their own feet and find what they need from reading. Skimming is quick reading for the general idea or ideas of a passage. There are preview skimming and over-view skimming, the former being used to decide whether or not to read something more

thoroughly, while the later being used when there is no time for a more complete reading. Scanning is looking for specific information using textual clues plus graph information. Finding information in a dictionary or telephone book is an example of scanning.

When students in ESL/EFL can feel comfortable about reading and find what they need in reading, they must have mastered all the skills discussed for the reading process. The next part of this paper will be devoted to reading and materials for English for Science and Technology.

English for Science and Technology is a promising and utilitarian subfield of English for Special Purposes which arose in the 1960's as a reaction to the general state of affairs in teaching English to speakers other than English. Research and analysis and preparations for ESL/EFL reading materials in the United States and the United Kingdom in the last fifteen years have made important contributions to teaching reading in English for Science and Technology.

English has played a very important role in science and engineering. UNESCO reported as early as 1957 that nearly two-thirds of engineering literature appeared in English, but more than two-thirds of engineers of the whole world could not read English. In countries like the Republic of China where textbooks in science and technology are mostly in English, a student's success or failure in science or technology is in large measure a consequence of success or failure in English. In such a situation, there is a need to see the role of English basically in terms of its accessibility to knowledge contained in textbooks, periodicals and journals, reports, manuals and abstracts. Under such circumstances, the role of English is associated with particular uses of English to extract information, interpret data and theories, report on latest advances in particular areas of specialist knowledge through reading. Before we go on to how to read EST, we have to identify difficulties our students encounter in their reading process.

The first difficulty that comes to mind is vocabulary which was mentioned in the first part of this paper but has not been discussed. Our intuitive thinking may dictate that technical and scientific terms can cause a great problem because they characterize technical and scientific prose and are essential to the meaning in the text. But findings from experimental studies have told us that our intuitive assumption is wrong. Selinker and Trimble (1974) found that non-technical words in technical writing would sometimes give students more difficulty than technical ones—e.g., adverbial phrases, conjunctions, or words used in anaphoric reference. Cohen et al. (1979) discovered from an empirical study that knowing technical terms in a particular field is not a sufficient condition for successful reading of specialized material. In fact, it is the non-technical terms in their text which created more of a problem. They realized that there are three areas of difficulty. The first area of difficulty arises because non-technical terms may take on technical meaning in a particular field; and the EFL reader may be aware of only one of the meanings of a word. The second area of difficulty is concerned with whether the author is using two or more words or phrases to refer to the same concept of a vocabulary item. For example, *assertions* might not be perceived by students as *statements*. The third area of difficulty they found from their study is that of specialized non-technical lexis. Examples of such vocabulary items which indicate time are *sequence* and *frequency*. Students often did not know words in this category: *initial,*

final, following, gradually, later, eventual, perpetual, succeeding, ensuing, preceding, progressively, simultaneously, alternately, consecutively, intermittently, subsequent, and *successive.*

On the syntactic level of EST materials, students in the same study had serious problems. They are the so-called "heavy noun phrases" in various syntactic functions. These phrases may serve as subject of the main clause or of a subordinate clause, and may also be used as object of a prepositional phrase. In an example from their biological study quoted below, the subject is submerged by its heavy modifiers:

> In many unicellular organisms and in some lower plants, nuclei contributing to the zygote are transferred between two cells without the formation of obviously specialized gametes by processes such as partial and temporary fusion of ciliated protozoans.

In the same study, the subjects could not pick up even the very basic conjunctive words signaling cohesion in English sentences. As conjunctives, or rhetorical devices play a very important role in reading comprehension, the importance of finding cohesive devices can never be overestimated. Without understanding cohesion in the text, readers will not be able to get a lower-level element in decoding and obtaining the meaning from the text.

On the discourse level, Selinker and the Trimbles (1976) have identified the learning problem for advanced learners: presuppositional information in EST discourse. This explained why their students were unable to "comprehend the total discourse in a paragraph even though . . . they may understand all the words in each sentence and/or all the sentences in that paragraph. That presupposition in EST was defined by Selinker as "information that the writer assumes that the reader shares with him". They have worked on articles and tense choice in presupposition in EST discourse. In the same article, examples of rhetorical functions in discourse are also given. In essence, rhetorical functions in EST discourse can be expressed both explicitly and implicitly. Explicitly stated, a formal definition, as an example, names the concept or phenomenon being defined, states the class to which it belongs, and distinguishes the term from other members of its class. An implicit definition, on the other hand, may mention its defining characteristics before the term itself, which often appears in a following sentence. Furthermore, an implicit definition is often embedded in some other rhetorical function, such as description of a mechanism. In the following are two examples of explicit and implicit definitions:

(a) Explicit Definition: Negative pressure is that type of pressure whose value is below atmospheric.

(b) Implicit Definition: (definition underlined)
From fluid mechanics it can be shown that as a fluid or gas passes through a venturi, its velocity increases; but its *pressure* decreases to *some value* below atmospheric. This negative pressure is greatest at the point in the throat where the fuel pick-up is located. (Selinker et al., 1976)

EFL students lack knowledge about implicit rhetorical functions and so cannot understand relationships such as those presented above in (b) and fail to grasp the information which the author intends to convey. This hypothesis of rhetorical functions has been empirically tested by Flick and Anderson (1980). They not only confirmed that

implicit definitions were more difficult than explicit definitions but also that native American English speakers found them inherently more difficult than explicit ones.

Having examined ESL/EFL learners' difficulty with EST discourse, I am going to summarize relevant findings in research which have pedagogical value and pedagogical implications.

Tenses seem to be related to the rhetorical structure of EST discourse. Selinker et al. (1974) generalize from technical reports the correlation between tense and rhetorical function. In this respect, EST articles fall into four main parts: background material and hypotheses, description of experiments, conclusions, and projective conclusions. In these four blocks, present tense is used for generally accepted facts and hypotheses; past tense is utilized throughout the description of experiments. Conclusion has two parts: summary conclusions and specific conclusions. Summary conclusions use present tense while specific conclusions, such as generalizations about the specific results of the experiments, use past tense. As projective conclusions can really serve as the opening remarks for another report, present tense is used, including such verbs used for hypotheses drawn from previous research: *suggests, appear.*

If more technical reports are taken into account, the generalizations of tense usage mentioned above seems not to be conclusive. Past experiments are also described in the present perfect tense if they are directly relevant to the present experiment. However, if they are less directly relevant they are described in the past tense. Past tense is used except when referring to physically present tables and other illustrations. But when illustrations are interpreted in terms of the experiments, the past tense is used.

Nevertheless, in reports where less emphasis is placed on actual experiments than on results, the present tense predominates, rather than the past tense.

In Selinker et al. (1974), presupposition and technical rhetoric are discussed. A declarative sentence asserts something which can be true or false. But what a sentence asserts is different from what a sentence presupposes. Whenever a sentence is used, some information must be assumed to be already somewhere, information without which the sentence would simply not make sense and would have no truth value at all. This information somewhere is defined as "presupposition".

One simple rehtorical structure is a paragraph consisting of a core generalization with supporting facts. In this case, presupposed clauses are not used to introduce core generalizations. In this type of paragraph development there is clearly stated (or clearly implied) a core generalization and supporting (developmental) information. In Selinker et al. (1978), this type of paragraph development is called rhetorical process development. This kind of paragraph development is set up by the rhetorical process hierarchy and characterizes a large number of EST paragraphs. Another type of paragraph development is called rhetorical function-shift development. In this kind of paragraph development, clearly stated core ideas are seldom found and ESL/EFL readers get lost in the whole paragraph. In order to gain access to the total meaning of a written piece of EST discourse, readers have to know shifts in rhetorical functions occurring within the same EST paragraph.

West (1980) did an empirical study on the relationship between that-nominal occurrence and rhetorical divisions within scientific research papers. Four major rhetorical divisions of a research paper–introduction, methods, results, and discussion were analyzed to find that-nominals. He found that the ratio of that-nominals per 100 T-

units for each rhetorical section of each article are respectively 32, 1.33, 14.71, and 24.94.

These findings in the density of that-nominal construction in research papers' rhetorical sections, in rhetorical process development and rhetorical function-shift development have shed light on our understanding of difficulty involved in reading EST discourse and on the principles of materials preparation and pedagogical considerations.

From what we see from the research mentioned above, preparation of materials for reading in EST is not to be dictated by needs assessment and vocabulary count for technological terms. To put in a more direct way, we need a completely new approach in teaching reading in EST. As pointed out by Mackay (1978), understanding intersentential relationships in discourse has become an important aspect of developing interpretive competence if we approach language use by emphasizing its functional aspect and through different acts of communication which are combined to produce a coherent and continuous passage of prose. Allen and Widdowson (1974) elaborate on this aspect by distinguishing use from usage, and the rhetorical coherence of discourse and the grammatical cohesion of text. Rhetorical coherence has to do with the ability to recognize how sentences are used in the performance of acts of communication and grammatical cohesion of text has to do with the ability to understand the rhetorical functioning of language in use. In practice, of course, one kind of ability merges with the other. In this sense, students have to learn how language is used to give expression to certain reasoning processes, how it is used to define, classify, generalize, to make hypotheses, draw conclusions and so on.

Bates (1978) adopted a functional/notional approach to syllabus design rather than structural/frequency count approach. He felt the need to teach the communicative value and situational use of language rather than paradigms of language forms in isolation from context. This approach has also been used by Wingard (1981) and Tyma (1981). Cowie and Heaton (1977) chose the following functions to develop their EST program: classification, definition, cause and effect, quantifying and measuring, hypothesizing, drawing conclusions, axioms, chronological procedures, issuing instructions, exemplification, comparing and contrasting, and presenting problems.

It seems on the right tract when the communicative value of language is valued in EST material preparation and functional/notional approach is adopted. As language teaching in recent years has been focusing its attention on the learner, Widdowson (1981) has second thoughts about a specification of the learner needs. In Wilkins' idea, (Wilkins, 1976), goal-oriented needs can determine the content of a course. But the kind of linguistic components that are specified represents only a part of the language knowledge and behavior that the learner needs to acquire eventually. Criteria for defining course content should operate on communicative competence. Therefore, a general language course should concern itself with those concepts and functions that are likely to be of widest value.

Using the redefinition of learning units as "concepts and functions", Widdowson questioned the wisdom of goal-oriented syllabus content. He argued that syllabus content should be determined by the process of learning. Teaching and learning cannot be assumed to be an equation. Therefore, we cannot allow the description of the language to be acquired to determine course content. Nor can we assume, Widdowson

argued, what is to be learned must be expressly and explicitly taught because learners have "an irritating tendency towards independent action and will frequently follow their own patterns of learning behavior in spite of the teaching patterns imposed upon them." These expressions of self assertion are interpreted by Widdowson as evidence that learners learn less than they are taught.

In Widdowsons' inference, a goal-oriented approach focuses on what the learner needs to have acquired after learning. This approach has a mistaken assumption that what the learner has to acquire necessarily has to be taught directly because in trying to place his or her product the teacher inhibits the very process that would enable the learner to eventually acquire it. Widdowson proposed a "process-oriented approach", one concerned with transitional behavior and the means of learning. This approach focuses on the presentation of language by reference to the means of learning and allows the ends to be achieved by the learner by exercising the ability he or she has acquired. It assumes that learning will continue beyond the completion of instruction since the aim of such instruction precisely is to develop a capacity to learn.

Two types of learners are cited by Widdowson: serialist and holists. Serialists prefer precision and rational control and incline towards the exact sciences, whereas holists prefer wider networks of association and for imaginative excursion and incline towards the arts and sciences. As a result, the methodology of different disciplines can be characterized in terms of cognitive styles, being formalizations of different ways of resolving problems and of conceptualizing and controlling reality. For the time being, definite distinctions between serialists and holists cannot be maintained. Widdowson therefore suggested that we should design EST programs by direct reference to the methodologies of subjects concerned on the grounds that these must of their nature incorporate the cognitive styles associated with their particular areas of inquiry. This process-oriented approach can satisfy the cognitive needs of the learners and guarantee the eventual attainment of the desired terminal behavior.

In conclusion, we find that different approaches to the reading process have sharpened our understanding of the problems involved and how to tackle them. They can be used in different areas of teaching reading and designing reading materials. As English for Science and Technology has become so popular a subfield in teaching English as a foreign language, we need to prepare reading materials for students in the light of fruitful research and theory.

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