An ESP Approach to Teaching Reading in Chemistry

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In this paper, first the characteristic features of the ESP (English for Specific Purposes) approach to second language teaching are reviewed, and a formal definition of the approach presented. Then, using this definition, the author describes a practical example of how the approach can be applied in the classroom, in the form of a detailed description of an ESP reading course aimed at undergraduate students of chemistry. Particular attention is paid to the development of specific linguistic, formal, and content schemata crucial for the successful reading of chemistry texts, and actually used classroom materials and activities are given to illustrate these ideas.

Introduction

ESP (English for Specific Purposes) has been one of the most important influences on EFL teaching since the first articles on discipline specific language features were published in the 1960s. Many universities around the world now offer courses on or relating to ESP, and there are a growing number of conferences, e-mail discussion lists and web-sites on the subject. Of course, the literature on ESP has also expanded dramatically (Swales, 1988), as has the number of ESP related classroom materials. Such has been the force of ESP that some have argued that the principles behind ESP teaching should be the basis of *all* EFL teaching (Hutchinson et al., 1987).

Despite the relatively long period of time that ESP has had to mature, surprisingly there is still a great deal of confusion about what ESP actually means. For example, there appears to be confusion as to whether or not EAP (English for Academic Purposes) should be considered part of ESP in general, as demonstrated in a recent discussion on the TESP-L e-mail discussion list (Anthony, 1988), and the textbook categories used in publishers' catalogs. More importantly, there is confusion about how ESP can or should be applied in the classroom. For example, in terms of applying ESP to say reading or writing, there seems to be a common misconception that if the subject matter of a course focuses on a specific discipline such as computing or medicine, then it is necessarily ESP orientated (and by the same argument, a course which focuses on more general subject matter is not).

Perhaps one of the problems is that ESP has developed at different speeds in different countries (Hutchinson, 1988). For example, in Japan ESP is still only discussed among a very small number of the EFL community, and its presence at EFL conferences in the country in minimal. Another problem relates to ESP teachers or practitioners in general. As Dudley-Evans (1998:5) notes, "[they] are so concerned with keeping up with the work and with discussing recent developments that they do not make time to define in any kind of detail exactly what they are doing."

This paper is aimed at newcomers to ESP who would like to know what ESP is, and how it can be applied in the classroom. The first of these questions will be answered in the form of a review of the various descriptions of ESP offered in the literature, which will lead to a formal definition of ESP, as proposed by one of the leading experts in the field. Then, using this definition, I will endeavor to show how ESP can be used as a guiding principle in the development of a reading course for undergraduate students of Chemistry. To illustrate the ideas in the paper, classroom materials and teaching methods will be given, and their problems discussed.

ESP: An approach to language teaching

As mentioned above, the history of ESP began in the early 1960s, however, since this time its meaning has changed somewhat. Early literature referred to ESP as English for *Special* Purposes, with the focus being on the teaching of special, or restricted, languages. Although the teaching of specialized language is still considered a part of ESP, it is now widely accepted that ESP does not necessitate the teaching of a restricted language. The converse can also be said, i.e., the teaching of a specialized language such as chemistry English or medical English is also not necessarily ESP (Dudley-Evans, 1998).

As Hutchinson et al. (1987) describe, ESP in not characterized by special content but rather by the specific purpose or needs of the learner. Thus, ESP is now the term used to describe English for *Specific* Purposes. Hutchinson et al. (1987: 19) go on to define ESP as "an approach to language teaching in which all decisions as to content and methods are based on the learner's reasons for learning". This is a similar view to that of both Mackay et al. (1978) and most recently Dudley-Evans (1997), who describes ESP as an "attitude of mind".

On the surface, there may not be any apparent difference between ESP and modern approaches to EFL teaching. Indeed, most EFL courses developed now are 'learner centered' and perhaps this demonstrates the influence that ESP has had on EFL teaching in general. Looking below the surface, however, we find a number of characteristics that distinguish the ESP approach from that of General English. First, as Johns et al. (1991) strongly argue, the context in which ESP courses are undertaken often dictates a specialized or unique methodology. For example, in EAP courses it may be necessary for the language teacher to work collaboratively with a specialist subject teacher. Dudley-Evans (1998) also argues that ESP courses are most effective when they adopt the underlying methodology of the discipline or profession of the

learner.

The other area in which the ESP approach differs from that of General English is in the coverage of the language. ESP courses will only cover those basic skills (listening, speaking, reading, writing) that are required by the learner's purpose. In addition, they will focus only on the themes and topics, grammar patterns, lexis, registers, discourses, genres and communicative needs that are necessary for successful realization of that purpose. In other words, the ESP approach involves more limitations or restrictions (Robinson, 1980).

Finally, there are a number of other features which characterize many ESP courses, although exceptions do exist. Strevens (1988) describes these as the 'variable characteristics' of ESP. For example, ESP courses tend to focus on a specific discipline or profession, are generally aimed at adult learners, and are often designed for intermediate or advanced learners who have already taken a more general English course. As Robinson (1980) describes, they also tend to be of a limited duration.

The above points are neatly summarized in the definition of ESP offered by Dudley-Evans (1998), which although being based on Strevens' (1988) offers a number of major improvements (see Fig. 1). In particular, he has removed the absolute characteristic that ESP is "in contrast with 'General English'" (Johns et al., 1991:298) and has revised and increased the number of variable characteristics. The only other addition necessary perhaps, is the inclusion of the limited duration variable characteristic mentioned above. Nevertheless, Dudley-Evans' definition is an excellent working definition of ESP that will be used here when considering the design of an ESP course for students of Chemistry.

Absolute Characteristics

1. ESP is defined to meet specific needs of the learners
2. ESP makes use of underlying methodology and activities of the discipline it serves
3. ESP is centered on the language appropriate to these activities in terms of grammar, lexis, register, study skills, discourse and genre.

Variable Characteristics

1. ESP may be related to or designed for specific disciplines
2. ESP may use, in specific teaching situations, a different methodology from that of General English
3. ESP is likely to be designed for adult learners, either at a tertiary level institution or in a professional work situation. It could, however, be for learners at secondary school level
4. ESP is generally designed for intermediate or advanced students.
5. Most ESP courses assume some basic knowledge of the language systems

Fig. 1 Definition of ESP (Dudley-Evans, 1998)

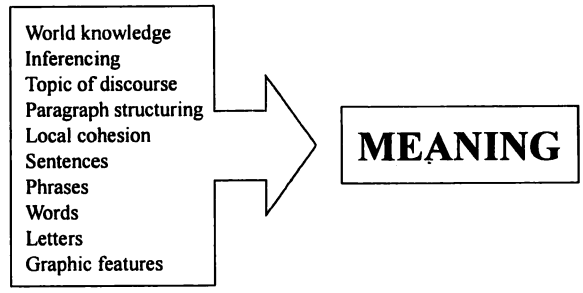

Fig. 2 An interactive model of the reading process (adapted from Grabe, 1998: 59)

Reading as an interactive process

Before discussing the development of a reading course based on the ESP approach described above, it is first necessary to define 'reading' as it is used here. In this paper, reading will refer to the process of constructing meaning from a text, through connecting information from the text with previous knowledge. Or as Wallace (1992: 39) describes, "meaning is created in the course of reading as the reader draws on existing linguistic and schematic knowledge and the input provided by the printed or written text". This definition of reading is fundamentally different from more traditional views of reading as a 'linear process', in which all the information is contained in the text, and the reader simply goes from the symbol to sound to meaning in a linear fashion. Here, reading is viewed as an 'interactive process' where the construction of meaning from text involves both lower level (bottom-up) processing strategies, such as rapid word recognition, knowledge of vocabulary, and syntactic pattern recognition, and higher level (top-down) processing strategies, such as inferencing, and knowledge of discourse patterns and text topics, working interactively (see Fig. 2).

Of course, the different strategies used during reading will depend on a number of factors, in particular, the reader purpose, the text type, and the context in which the reading is to take place (Wallace, 1992). For example, if the text type is a newspaper article and the reader only intends to surmise the main points of the story, they are more likely to employ higher (top-down) strategies using knowledge of paragraph and discourse structure, and world knowledge to skim read the text. A good place to start in developing a reading course, therefore, is to specify the purposes, text types, and context in which the learners will engage in reading. In other words, we must specify the reading needs of the learners, which is the most important defining element of the ESP approach itself (see above). Once these are established, it is then a matter of developing the appropriate materials and activities which will help develop the necessary processing strategies to meet these needs. Ideally, these maberials and activities will match the kinds of reading tasks learners will eventually be required to do in the target context, the second absolute characteristic of the ESP approach. Finally, by carefully analyzing the text types typically used in the field, the key vocabulary, grammar structures and so on can be identified and made the focus of classroom

instruction. In this way, the third absolute characteristic of an ESP approach will also be realized.

In the remainder of this paper, the specification of learner needs, the analysis of target text types, and ideas for suitable materials and classroom exercises will be given for a reading course designed for undergraduate students of applied chemistry.

Developing an ESP Reading Course

Background

The reading course describe here was designed for third year undergraduate students of applied chemistry at a national university in Japan. Having studied at least eight years of English in junior and senior high school, and the first years of university, the students had a relatively good knowledge of English grammar and general vocabulary. However, due to large classes and traditional teaching practices in Japan, they had little practice in applying these skills and suffered from a low motivation towards English in general. Compared with other national university students, they were also considered to have a lower English proficiency level because the entrance examination for the department did not include an English element.

Learner 'Needs' and 'Wants'

In order to assess the needs of the learners, the opinions of staff of the Applied Chemistry Department were gathered, from which it was found that 40% to 50% of students would continue onto graduate school where they would be required to read research articles in English. In particular, the understanding of the research article abstracts was felt to be most important because it could be used to obtain a summary of the research, and was also a key part of writing and understanding research presentation proposals.

In addition to interviews with staff, the target students were asked to complete a survey on their reading needs and goals. Surprisingly, very few believed that reading was crucial to their future research aims, and instead suggested a preference to studying conservation skills, especially listening and pronunciation. Although these 'wants' were in stark contrast to the 'needs' expressed by the staff, they would have to be in someway accommodated in the course, otherwise the students may simply reject the course as irrelevant.

Course Goals

In view of the learner needs and wants described above, the first goal for the course was to generate in students an appreciation of the importance of reading in chemistry. This involved an orientation to chemistry research in general, and the importance of reading about other research through research articles and abstracts. A second goal was to develop in students a new interest in reading. Here, it was hoped that adopting the ESP approach to reading, with its focus on content-based materials directly relevant to the academic goals of students, would partially assist in reaching this goal

(Eskey et al., 1988). There was also a lessened importance attached to grammar and English-Japanese translation exercises, commonly used in technical reading courses in Japan, which the students reported a dislike towards.

Finally, the course focussed on language problems associated specifically with reading chemistry research article abstracts. (Due to time restrictions, other parts of the research article were not covered during the course). In particular, an emphasis was placed on the bottom-up processing strategies of developing a large receptive vocabulary, accurate and rapid word and syntactic pattern recognition, and strategies to deal with complex noun-phrases. Top-down processing strategies were also covered, namely, the development of field knowledge of chemistry research, knowledge of typical text structures used in chemistry abstracts, and flexibility in applying processing strategies to different texts for a variety of purposes.

Vocabulary Development

As Grabe (1988:63) describes, one of the most crucial elements for successful reading is a "massive receptive vocabulary that is rapidly, accurately and automatically accessed". Without this, the learner will be forced to rely on higher-processing strategies to predict or guess the meaning of words, limiting the amount of cognitive space left for interpreting the meaning of the text as a whole (Grabe, 1988: Eskey, 1988). To achieve this goal the learner is faced with two problems; the first is cognitive in that the learner must know the meaning of the word, and the other is perceptual in that the word must be immediately recognized (Eskey, 1988).

To deal with the cognitive problem, students were first offered a number of 'good' vocabulary learning strategies, such as the use of word-cards and revision planning, and key-words from texts were tested each week. Specially adapted texts were also used to highlight particular types of vocabulary, in particular technical terms, semi-technical terms and non-technical terms. As Cohen et al. (1988) report, the last of these causes problems for students when they are used technically or when they are used as contextual paraphrases. The text below is an example of one of these so called 'easified' texts (Bhatia, 1993: Noguchi, 1998) highlighting the use of technical terms used in a modest chemistry abstract.

ABSTRACT: Allosamidin, recently isolated from mycelial extracts of *Streptomyces* sp. 1713, is a powerful and selective chitinase inhibitor. The total synthesis of allosamidin is described herein. The electric eel acetylcholinesterase-mediated enantioselective hydrolysis of (*trans,trans*)-2-(benzyloxy)cyclopentene-1,3-diol diacetate accessed a monoacetyl derivative. Five additional steps produced a protected version of the aglycon ("allosamizoline") sector of allosamidin. An allyl derivative stereoselectively reacted with benzenesulfonamide in the presence of a halonium source to afford a 2β-halo-1α-sulfonamidohexose. Treatment of this product with a strong base generated an intermediate 1,2-sulfonylaziridine, which was trapped with a protected allyl derivative to provide a disaccharide glycal. Reiteration of this scheme gave access to the required trisaccharide. Following deprotection, the total synthesis of allosamidin was accomplished. In addition, the method, with modification, gave access to several allosamidin analogs.

Example 1 An 'easified' authentic abstract highlighting technical terms used in chemistry abstracts

Abstract: Allosamidin, recently isolated from C, is a powerful and selective inhibitor. The total synthesis of Allosamidin is described herein. The X hydrolysis of compound A accessed a B derivative. Five additional steps produced an intermediate C. A derivative of C reacted with compound D in the presence of F to afford an intermediate G. Treatment of this product with a strong base generated an intermediate H, which was trapped with a derivative I to provide an intermediate J. Reiteration of this scheme gave access to the required intermediate K. Following deprotection, the total synthesis of Allosamidin was accomplished. In addition, the method, with modification, gave access to several Allosamidin analogs.

Example 2 An 'simplified' authentic abstract highlighting semi-technical terms used in chemistry abstracts

Another technique used was to ask learners to generate these easified texts on their own or in groups. This was particularly effective as it forced students to actively engage with the texts, and take command of their own learning agenda. Of course, simplified texts can also be used effectively to develop vocabulary skills. For example, one problem faced by students of chemistry is the high number of compound names in abstracts, the relevance of which can only be understood if they are actually used in research projects. Therefore, by replacing these terms with letters or symbols, the text can be made more accessible to inexperienced students, as Example 2 shows. Note, this is a simplified version of the text used in Example 1, here with semi-technical vocabulary highlighted.

To develop in learners and increased perception rate of vocabulary items, two techniques were used. The first was the use of 'timed readings', which force the students to process words in larger groups or chunks (Eskey et al., 1988). Many authors agree, however, that substantially improved perception rates can only be achieved through extensive reading (Eskey et al.,1988: Day et al., 1998). The students were therefore required to read a great deal both inside class, during periods of silent reading, and outside class as part of homework tasks.

Syntactic Problems

Although the vocabulary problems associated with reading chemistry abstracts are indeed great, in terms of syntax they are far less problematic. A number of areas which cause problems for learners have been discussed in the literature. In particular, the use of articles and verb tenses (Selinker et al., 1974) and the use of modal verbs in scientific discourse (Lackstrom, 1978). One area that the learners here found difficult was the extensive use of long, complex noun phrases, a problem discussed in detail by Cohen et al (1988). Again, the use of easified and simplified texts were useful in helping students identify where these phrases began and finished, as were exercises in which the students themselves identified the phrases in authentic texts. Student-centered analysis of texts also helped students to understand the structure of the noun phrases, and to break them down into their component parts.

Developing Top-Down Reading Strategies

Although bottom-up processing strategies are basic to effective reading, the inter-

active model of reading shows that top-down processing strategies will also play a major role in successfully comprehending a given text. As Carrell et al. (1988:76) have long argued, "comprehending words, sentences, and entire texts involves more than just relying on one's linguistic knowledge... Efficient comprehension requires the ability to relate the textual material to one's own knowledge". Here, because the students were still only in their third year at university, they had little exposure to chemistry research, and so reading chemistry abstracts would have little relevance to them. Therefore, it was necessary to supply some of this background knowledge in the form of an orientation class (see above), where the role of the abstract and the research article in general was clarified. Care was also taken to ensure that the content of the selected abstracts could be understood by students at this level. Unfortunately, this led to a strong bias towards texts describing the organic synthesis of a certain compound. In the future, however, it is hoped that by closer collaboration with department staff, a wider variety of texts at an appropriate level can be selected.

Another problem facing students was their lack of knowledge of formal schemata used in chemistry abstracts. In other words, they were unaccustomed to the typical ways in which abstracts were structured. As many authors have reported (e.g. Carrell et al., 1988), this can cause serious comprehension difficulties. To deal with this, a corpus of chemistry abstracts were analyzed by the author and two of the more commonly used text structuring patterns were formally presented to the students; namely, the 'problem-solution' pattern (Hoey, 1994) and the ' experimental' pattern (Weissberg et al., 1990). Students also engaged in a number of consciousness raising exercises such as mapping texts to a particular structure pattern (Carrell, 1988), re-arranging jumbled texts according to a certain structure type (Swales, 1981), and student-centered analysis of texts to reveal the structure patterns incorporated. Of course, the skills needed to successfully complete this last activity were developed gradually, first using simplified texts, and gradually building up to simple and then advanced authentic abstracts. To illustrate the kinds of activities possible, below is an

1. The extensive determination of $^{18}O/^{16}O$ ratios for each product ion bearing differing numbers of incorporated ^{18}O atoms resulted in the complete assignment of the labeled positions with accurate isotope ratios; the positions labeled from molecular oxygen ($^{18}O_2$) were O(1)/O(2), O(3), O(5), O(6), O(8), O(9), O(10) and O(12).
2. Its biosynthesis attracts considerable attention since the carbon skeleton has been shown to be synthesized via an unusual route.
3. These incorporation patterns suggest that the cyclization of ether rings C, D and E occurs via a beta-epoxide intermediate at C22-C23, and the carboxylic acid is formed by Baeyer-Villiger oxidation.
4. Those labeled from [$^{18}O_2$]acetate were O(4), O(6), O(7) and O(11) (oxygen atoms are numbered beginning with those of carboxylic acid as O(1)/O(2) to O(13) in ring G).
5. We applied collision-induced dissociation tandem mass spectrometry (CID MS/MS) to the elucidation of the ^{18}O-incorporation pattern of okadaic acid.
6. Okadaic acid (1) is a polyether compound produced by the marine dinoflagellate *Porocentrum lima*.
7. However, a very limited amount of information is available for the formation of its ether rings.

Example 3 A 'jumbled' text to be re-arranged according to the 'problem-solution' text-structure pattern

example of a jumbled text which would be re-arranged according to the 'problem-solution' pattern.

As the example shows, such exercises can also offer students valuable practice in interpreting cohesion devices, such as repetition, ellipsis, and conjunctions, which are known to cause difficulties particularly when reading scientific discourse (Cohen et al., 1988). As Cohen et al point out, however, there is a danger in attending too much to such overt markers of discourse structure, as students may then be unprepared for texts which do not use them. Therefore, care was taken to ensure students were exposed to a variety of texts and reading tasks and to think consciously about which, when and where particular strategies will prove most effective. Such a view is also held by Carrell (1998) and others, who have recently advocated a metacognitive approach to strategy training, where the explanation of a strategy should include not only what it is, but also why it should be used, how to use it, when and where it should be used, and how to evaluate the use of the strategy.

Conclusion

Although by definition many of the activities and materials described here cannot be directly transported to different classroom contexts, where the students will inevitably have different needs and problems, it is hoped that by explaining the principles on which the course was based a teacher new to ESP will have the basic tools necessary not only to design, but also successfully carry out an effective ESP reading course. Indeed, the basic ideas of ESP described here, such as the assessment of learner needs through collaboration with field specialists and student surveys, and the development of materials based on an analysis of target texts are subject independent. There is, however, a great need for further study of problems associated with reading in specific disciplines. For example, there is still a common misconception that the reading problems faced by engineers in say, computer science, will be the same as those faced by engineers in other fields. Therefore, it is hoped that in the future, research will concentrate more on the differences between disciplines, enabling ESP practitioners to design courses more closely tailored to their learners' specific needs.

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