

# L2 Students' Metacognitive Awareness of Reading Strategies and its Relationship to Reading Comprehension

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*The present paper investigates students of English as a foreign language's metacognitive ability. Metacognitive ability refers to the learners's knowledge about their own cognitive resources, and their control of that knowledge in the learning situation. That knowledge will help them meet the demands of a learning situation more effectively and to take preventive actions to anticipate or recover from problems.*

*We concentrate on silent reading and undertake a study to investigate the metacognitive awareness of foreign language readers about their perceived ability to read in English and about the strategies they consider effective and focus on to read effectively in their foreign language (English), and its relationship to their reading comprehension performance.*

*We think that reading comprehension can be improved if teachers learn about their subjects' beliefs and expectations about language learning in general and about strategies for reading in a foreign language in particular.*

## 1. Introduction

The purpose of this paper is to investigate metacognitive awareness of reading strategies. We carry out an analysis of non-native students' ideas about using certain strategies and about their potential effectiveness. Two main reasons justify this work. First, we know very little about metacognitive factors in second language reading. At the same time research has found that knowing about the nature of reading and about one's reading strategies will help inefficient readers to become better readers.

A large body of research in second language reading has focused on readers' strategies. Researchers like Grellet (1981), Omaggio (1984), Hosenfeld et al. (1981), Loew (1984) defend the benefits for L2 students' reading of being taught reading strategies. Several empirical investigations have been conducted into reading strategies and their relationships to successful and unsuccessful second language reading (Hosenfeld, 1977; Haupman, 1979; Devine, 1984; Knight, Padron and Waxman, 1985; Block, 1986; Sarig, 1987). These strategies include skimming and scanning, contextual guessing, reading for meaning, making inferences, predicting, previewing, anticipation, and more recently recognised strategies such as building and activating appropriate background knowledge and recognising text structure.

Metacognitive knowledge refers to the general assumptions that students hold about themselves as learners, about factors influencing language learning and about the nature of language learning and teaching. Only recently has metacognitive knowledge begun to receive attention in second language research. A number of these studies have pointed out that the way in which learners perceive language learning may have a significant impact on their learning outcomes (e.g. Reid and Hresko, 1982; Weinert and Kluwe, 1987). According to these findings, successful learners develop insightful beliefs about language learning processes, their own abilities and the use of effective strategies that may compensate for possible weaknesses. This, in turn, has a facilitating effect on students' learning, for they see themselves as initiators of their own learning and it helps them to rely on their own potential as good language learners. Needless to say, these students tend to develop a more active, and thus, autonomous attitude that allows them to take charge of their learning whatever the situation may be.

Some research has begun to focus on students' awareness of reading strategies. Relevant research on metacognitive strategy training has been conducted in second language reading by Carrell, (1985, 1989b), Padron, (1985), O'Malley, (1987), Sarig and Folman, (1987), on the assumption that, as we said before, knowing about the nature of reading and about one's reading strategies will help inefficient readers to become better readers. Thus if a reader is aware of what is needed to perform effectively, then it is possible to take steps to meet the demands of a reading situation more effectively. If, however, the reader is not aware of his or her own limitations as a reader or of the complexity of the task at hand, then the reader can hardly be expected to take preventive actions to anticipate or recover from problems. A series of studies investigate the relationships between perceptions about strategies, strategy use and reading comprehension (Waxman and Padron, 1987; Padron and Waxman, 1988; Barnett, 1988; Carrell 1989a).

Carrell's (1989a) study focuses the metacognitive awareness of second language readers about reading strategies in both their first and second language, and investigates the relationship between their metacognitive awareness and their comprehension in both first and second language reading. She observed a significant relationship between metacognitive awareness about reading strategies and reading performance. Thus, the subjects' preference for global or local strategies had an effect on reading performance. Global strategies have to do with use of background knowledge, reading for the text gist and use of textual organization, whereas local strategies are those relating to sound-letter, word-meaning and sentence syntax.

In Carrell's study this preference varied according to whether the subjects were reading in a first or in a second language. For reading in the first language, readers tended to prefer global strategies and local reading strategies tended to be negatively correlated with reading performance. For reading in a second or foreign language, the Spanish L1 group reading in English as a second language (ESL), of more advanced proficiency levels, tended to be more global in their perceptions of effective and difficulty-causing reading strategies and for this group some global reading strategies were positively correlated with reading performance, whereas the English L1 group reading in Spanish as a foreign language (EFL), at lower proficiency levels tended to be more local in their perceptions of effective strategies. Some of the local and difficulty-causing reading strategies were positively correlated with reading performance.

## **2. Our research study**

Our study continues the analysis of metacognitive perceptions of non-native readers about reading strategies and the influence these perceptions or ideas may have on second language reading performance.

As we have said before, students carry beliefs about their weaknesses and strengths and their self-concept as learners, and they also

develop some ideas about using certain strategies and about their potential effectiveness. This paper undertakes an analysis of these beliefs and ideas in students of English as a foreign language. We carry out a descriptive study about students' perceived ability to read in English and about the strategies they consider effective and focus on to read effectively.

We also carry out an empirical study about the relationship between our students' judgments about the effectiveness of the various reading strategies and the effectiveness of their reading. We hypothesize that different results to those in Carrell's study might emerge from a similar study but with different kinds of subjects. The subjects of our study are all students of English as a foreign language, at a low proficiency level in English. As this is the profile of the students we usually work with we hope that the results we obtain will contribute to improving both our knowledge of our students and our teaching.

### **3. Metacognitive questionnaire**

A questionnaire was used to elicit relevant information about the subjects' ideas about their own reading and their judgments about silent reading strategies. It consists of three groups of statements.

The first group of statements is related to the subjects' perceived reading ability in the target language. It includes the techniques and resources which characterize a good reading behaviour, as they appear in the literature (Grellet, 1981; Nuttall, 1996; Silberstein, 1994). This first group consists of six statements which enquire about the faculty of predicting or guessing what is to come next in the text, about anticipation or the ability to use prior knowledge and experience to understand the content of the text, about whether subjects recognize the organization of the text, distinguishing between main points and supporting details, and relating information which comes next in the text to previous information in the text, about whether subjects are able to assess and evaluate the text, being aware of the

writer's intention, of his point of view and possible bias, and about whether they have a good sense of when they understand something or not.

The next group of statements tries to reveal the reader's resources to face problems during reading and solve them satisfactorily. They are five statements pertaining to what subjects do when they do not understand something, whether they use some repair strategies or give up and stop reading.

The rest of the questionnaire consists of seventeen statements about what the subjects do to read effectively and about reading behaviours of good readers. Within these categories individual items focus on various types of reading strategies related to reading comprehension (Hosenfeld 1977; Brown 1980; Baker and Brown 1984; Devine 1984; Block 1986; Bartnett 1988): 1) phonetic, pronunciation, or sound-letter aspects of decoding; 2) word-level aspects of meaning; 3) sentence, syntactic decoding; 4) details of text content; 5) global aspects of textual meaning, or text gist; 6) background knowledge; and 7) textual organization.

These three groups of statements are taken from Carrell's (1989a) questionnaire. We thought that the information they contain could provide complete and relevant information about the subjects metacognitive conceptualizations about reading strategies. They cover reading techniques, repair strategies a reader uses when comprehension fails and the reading strategies related to comprehension suggested in the literature.

Using a 1-5 Likert Scale (1=strongly agree, 5=strongly disagree), subjects judged twenty-eight statements about silent reading strategies in English. In order not to have level of language proficiency in the second language affect results on the metacognitive questionnaires, subjects received the questionnaire in their native language (see questionnaire in Appendix I).

#### 4. Subjects.

A group of eighty-eight native speakers of Spanish participated in the study. These subjects were studying at the Technical University School of Industrial Engineering in Gijón. They were of low proficiency level in English.

#### 5. Procedures.

Subjects read a text in English and answered six comprehension questions about the text (cf. Appendix II), then responded to the metacognitive questionnaire about reading in that language. The text was on the topic of corrosion, with a problem/solution type of rhetorical organization. The text was an excerpt from an article by P. Tweedale entitled «Beating the fire risk with water based hydraulics» from the journal *Professional Engineering*. This is typical of the material the informants were regularly required to read throughout their courses.

#### 6. Results

Descriptive and correlational statistics based on the response data were obtained using the statistical program SPSS for Windows 6.0.

##### 6.1. *Descriptive analysis*

We will start analysing each variable separately. Within the ability item group, the first six statements in the questionnaire, a high proportion of the subjects agreed with statements 2, 3, 5 and 6 (mean values= 2.5; 2.419; 2.126; 1.437 respectively).

Thus, 53.4% of the subjects agreed with the statement that when reading silently in English, they were able to anticipate the difference between main points and supporting details whereas 11.6% of the subjects disagreed with this statement; a high proportion of subjects (61.7%) agreed with the statement that when reading silently in English, they were able to relate information which comes next in the text to previous information in the text, and only 7% disagreed with

this statement. A large number of subjects (74.7%, of which 52.9 agreed and 21.8 strongly agreed) said that they were able to use their prior knowledge and experience to understand the content of the text they were reading, and 95.4% of the subjects stated that they had a good sense of when they understood something and when they did not (of these 62.1% strongly agreed with this reading ability).

With respect to statement 4 (when reading silently in English I am able to question the significance or truthfulness of what the authors says), 43% of the subjects showed a neutral attitude towards this ability, although more agreed (36.1%) than disagreed (20.9%) with it, the mean value was 2.779.

Finally, 40.7% of the subjects disagreed and 11.6 strongly disagreed with the statement that when reading silently in English, they were able to anticipate what would come next in the text (mean value=3.512).

With respect to repair strategies or what they do when they do not understand something (statements 7 to 11 in the questionnaire), a large proportion of subjects (80.4%) said that when they did not understand something, they kept on reading hoping for clarification further on (mean value 2.034); 71.2% said that they reread the problematic part (mean value=2.184); 66.3% went back to a point before the problematic part and reread from there (mean value=2.337); 60.4% affirmed that they looked up unknown words in the dictionary (mean value=2.337). Finally, 52.3% strongly disagreed and 31.4 disagreed with the statement that when they did not understand something they gave up and stopped reading (mean value=4.279).

With respect to the strategies that our students tended to focus on in order to read more effectively (statements 12 to 20), 94.1% of the subjects tended to focus on getting the overall meaning of the text (52.4% of the subjects strongly agreed and 41.7% agreed with this statement; mean value=1.560), 60.7% tended to focus on relating the text to what they already know about the topic (mean va-



lue=2.429), 59.8% tended to focus on understanding the meaning of each word (mean value=2.378), and 47% tended to focus on looking up words in the dictionary (mean value=2.578).

On the other hand, the subjects did not focus to read effectively on mentally sounding out parts of the text (37.8% disagreed and 31.7 strongly disagreed with this statement; mean value=3.915) and being able to pronounce each whole word (34.9% strongly disagreed and 31.3 disagreed with this statement; mean value=4.253).

They showed a neutral or intermediate level of agreement with the strategies of using the organization of the text, the grammatical structures, and focusing on the details of the content to read effectively (42.2%, 41% and 46.4% of the subjects respectively neither agreed nor disagreed with these strategies; mean value=3.084, 3 and 3.083 respectively).

That is, the subjects tended to focus in order to read more effectively on two strategies that refer to global aspects of textual meaning and background knowledge, and on two local strategies, understanding the meaning of each word and looking up words in the dictionary.

In the case of what are perceived to be effective strategies characteristic of the reading behaviours of the best readers subjects know (statements 21 to 28), these are, in order of preference: understanding the overall meaning of the text (62.7% strongly agreed and 28.9 agreed that this strategy was effective; mean value= 1.494), guessing at word meanings (39% strongly agreed and 29.3 agreed with this statement; mean value=2.098), integrating the information in the text with what he/she already knows (66.3% agreed that this strategy was effective; mean value=2.205), recognizing words (64.6% agreed that this strategy was effective; mean value=2.293), grasping the organization of the text (61% agreed with this statement; mean value=2.207), focusing on the details of the content (45.8% agreed with this statement; mean value=2.651), and sounding out words (39.8% agreed with this statement; mean value=2.964).

Subjects do not find effective using a dictionary (42.7% disagreed with this strategy and only 25.7 agreed with it; mean value=3.293).

That is, they perceive all the strategies to be effective except for using a dictionary although we observe that the global strategies, understanding the overall meaning of the text, integrating the information in the text with what is already known and the local strategy of guessing at word meanings are the ones considered effective by a higher proportion of subjects.

### 6.2. *Reading Comprehension Test*

The results of the comprehension test show that 85.9% of the subjects understood the text (44.7% completely and 10.6% half of it).

### 6.3. *Relationship subjects' metacognitive judgments/reading comprehension*

The next step was to analyse the relationship between the subjects' metacognitive awareness expressed in their answers to each statement in the questionnaire and their reading comprehension performance.

For each statement we obtained the correlation coefficient. The correlation coefficient shows the correlation between the answers to each statement and the subjects' reading performance. We observe that the correlations are small, never close to  $-1$  (high inverse correlation) or  $+1$  (high direct correlation). They are not significant.

The probability was not significant for any of the statements either (it was not lower than 0.01). It varied from 0.986 in statement number 26 (The best reader I know in English is a good reader because of his ability to integrate the information in the text with what he/she knows) to 0.037 in statement number 5 (when reading silently in English, I am able to use my prior knowledge and experience to understand the content of the text I am reading).

Thus, unlike Carrell, we did not find a significant correlation between the students' metacognitive awareness, that is, their self-concept as readers, their ideas about using certain strategies and their potential effectiveness, on the one hand and their reading comprehension performance on the other.

Next we analysed the subjects' tendency towards or preference for global or local strategies. Global strategies have to do with use of background knowledge, reading for the text gist and use of textual organization, whereas local strategies are those relating to sound-letter, word-meaning and sentence syntax.

#### 6.4. *Tendency towards global or local strategies*

In order to analyse the subjects' tendency towards global or local strategies, subjects were divided into two mutually exclusive subgroups on the basis of their responses to the effective items on the questionnaire. Following Carrell (1989a) of the nine items on the strategies subjects focused on to read more effectively, the six items relating to sound-letter, word-meaning, sentence syntax and text details were classified as local items; the remaining three relating to background knowledge, text gist, and textual organization were classified as global items. Of the eight items on what subjects judged as effective reading behaviours, the five items relating to sound-letter, word-meaning and text details were classified as local items; the remaining three relating to background knowledge, text gist, and textual organization were classified as global items. We called the group of statements on the strategies subjects focused on to read more effectively group A, and the group of statements on what subjects judged as effective reading behaviours group B.

We calculated the mean of the subjects' responses to each subgroup of statements: A (effective)-global, A (effective)-local, B (effective behaviour)-global, B (effective behaviour)-local. Then the mean of the responses to the local statements was taken away from the mean of the responses to the global statements (a positive value

would express a local tendency). The resulting means are shown in Table 1 below:

A	0.85
B	0.69

TABLE 1: Mean tendency to global/local strategies

The mean obtained in the group of statements on the strategies subjects focused on to read more effectively (group A) showed a preference for local strategies.

The mean obtained in the group of statements on what subjects judged as effective reading behaviours (group B) showed a preference for local strategies.

After studying the subjects' tendency with respect to global and local strategies we analysed the relationship between this tendency and reading performance.

### 6.5. *Relationship between tendency towards local /global strategies and reading performance*

In order to analyse the relationship between the tendency towards global or local strategies, and reading performance we calculated the probability and correlation coefficients. The correlations were very small, as Table 2 below shows. No significant correlation is observed between the tendency towards local or global strategies in any of the two groups of statements, and reading performance. The probability is not significant either:

	Correlation coefficient	Probability
A	-0.0873	0.444
B	0.1051	0.357

TABLE 2: Relation mean tendency towards local /global strategies and reading performance.

Thus, the results obtained in the comprehension test are not influenced by the students' preference for global or local strategies.

After obtaining these results, we studied in more detail the tendency towards local or global strategies analysing it within the students. We divided the subjects in terms of this tendency, manifested in their response to the two groups of statements related to efficiency using a cluster analysis.

### 6.6. Cluster Analysis

In this section we will explain the cluster analysis we carried out to classify the subjects in terms of their tendency towards local or global strategies. A cluster analysis is a conglomerate analysis. This analysis includes a series of techniques, mainly algorithms, which aim to search for groups of subjects or variables which are similar and which are then grouped in conglomerates or clusters (Bisquerra, 1987).

In our case we intended to form clusters according to the preference for global or local strategies, so that the differences should be minimum within the cluster and maximum between any two different conglomerates. To carry out a cluster analysis it is necessary the choice of an algorithm which allows the inclusion of each subject in one of the groups. There is a wide variety of techniques of cluster analysis (see Ruiz Vega 1993). We used the hierarchical method and the iterative partition method because these are the ones the SPSS program allows using. The hierarchical methods carry out a

process of classification of the subjects with the object of obtaining groups with high internal cohesion. For their part, the iterative partition methods, which differ from the hierarchical methods in that they classify again every element in each iteration until the final sample, have appeared to avoid the disadvantages of the former methods, of which the principal is that once an element is assigned to a cluster, this assignation is never questioned in the subsequent procedure, therefore the first classifications of the elements are fundamental to guarantee an adequate typology of the subjects analysed. The iterative partition methods classify the elements in a number of groups previously specified, normally in a provisional way, to subsequently analyse the composition of each cluster in order to achieve some preespecified norm, in such a way that the subjects are reclassified in each iteration, which permits avoiding poor initial assignations. However, the main disadvantage of these methods is the relative facility to generate typologies which are not significant, resulting from a poor initial division of the initial data, which happens frequently if a random initial division of the data is carried out.

To solve this potential problem, Punj and Stewart (1983) recommend to apply successively a hierarchical method (for a previous analysis of the data), and an iterative partition method (which uses the sample generated by the hierarchical method as the initial division to generate the optimum taxonomy). This is the process we have followed in this study.

Starting with a hierarchical method, and then applying an iterative partition method (K-means), we obtained the clusters needed for doing our work. We use the K-means method since this analysis procedure can be used to form clusters when the number of subjects is large, which is the case with our study. In this procedure, each subject is assigned to the nearest cluster, calculated by minimizing the euclidean distance from the subject to the centroid of each conglomerate. In this way, the first sample (from the application of the

hierarchical method) gives us two, three and up to six groups. Then we do the same analysis applying an iterative partition method, taking as the basis the sample obtained after applying the hierarchical method. We analysed the partitions and decided to use the partition in three clusters since these were the ones which provided more relevant information about the tendency of the subjects towards globality and locality.

We started analysing the clusters obtained from the answers to the group of statements on the strategies subjects focused on to read more effectively. The three clusters showed a tendency towards local strategies, tendency which is higher in cluster 2 (1.8564), intermediate in cluster 3 (0.8126) and low in cluster 1 (0.0516). The number of subjects in cluster 2 is 13, in the third cluster 37, and 31 in cluster 1. There is a clear tendency to focus on local strategies to read more effectively. The higher percentage of subjects (see Table 3 below) is in the cluster which shows an intermediate tendency to local strategies (cluster number 3).

	HIGH	MEDIUM	LOW
Subjects	13	37	31
Percentage	16.04	45.67	38.2

TABLE 3: Cluster of subjects according to their local/global tendency in group A of statements.

In the group of statements on what subjects judged as effective reading behaviours, two of the clusters, clusters 1 and 3 showed a tendency towards local strategies, that is, the subjects in these clusters tended to consider the use of local strategies effective. This tendency is higher in the third cluster (1.8625) than in the first (0.6109). Cluster 2 showed a tendency to global strategies (-0.7333), that is, subjects in this cluster tended to judge global strategies as characteristic of the reading behaviour of effective readers. The sub-

jects in the first cluster are 43, 21 in the second and 16 in the third. The number and proportion of subjects in each cluster appears in Table 4:

	LOCAL HIGH	LOCAL LOW	GLOBAL
Subjects	16	43	21
Percentage	20	53.7	26.25

TABLE 4: Cluster of subjects according to their local/global tendency in group B of statements.

Now we will show the profiles of each of the clusters. These are obtained taking as the basis the result of the cluster analysis and calculating the mean value of the results obtained by the individuals in each cluster.

In the group of statements on the strategies subjects focused on to read more effectively, we have seen that the three clusters show a tendency towards local strategies. In cluster 1 (low tendency to local strategies), the mean score on the reading comprehension test is 4.67 (out of a maximum of 6). In cluster 2 (high tendency to local strategies) the mean is 4.76 and in cluster 3 (intermediate tendency to local strategies) the mean is 5.15. The highest mean score is in the group of subjects with an intermediate tendency to local strategies.

In the group of statements on what subjects judged as effective reading behaviours, clusters 1 and 3 showed a tendency to local strategies. The mean score in these clusters is 4.85 and 4.76 respectively. In cluster 2, which shows a tendency to global strategies the mean score on the comprehension test is 5.09.

As we can see, the mean scores on the reading comprehension test are similar in the clusters. We can confirm that the preference for global or local strategies does not have a significant influence on comprehension.



## 7. Conclusion

We have carried out a descriptive study to investigate our readers' perceived ability to read in English and their judgments about the efficiency of the various reading strategies. Regarding this question, the following results are noteworthy:

Subjects see themselves as able to use prior knowledge and experience to understand the content of the text, able to recognise the organization of the text, to assess and evaluate the text and capable of knowing when they understand something and when they do not. They see themselves as resourceful readers who in the face of reading difficulties use strategies to clarify the meaning instead of giving up and stop reading.

Subjects tended to focus on in order to read more effectively, and tended to judge as effective strategies two strategies that refer to global aspects of textual meaning and background knowledge, and two local strategies, understanding the meaning of each word and looking up words in the dictionary.

We also carried out an empirical study about the relationship between the readers' ideas and judgments about the effectiveness of strategies and their reading performance. We did not find a significant correlation between the students' ideas about strategies and their potential effectiveness, and their reading comprehension performance.

When we analysed the general tendency to global or local strategies subjects tended to focus on local strategies to read more effectively, and tended to judge local strategies as effective. When we analysed the tendency to global or local strategies more specifically within the students using a cluster analysis, the same tendency towards local strategies was found. This result coincides with Carrell's (1989) a study where the Spanish-as-a-foreign-language group tended to be more local in their perceptions of effective reading strategies.

However, unlike Carrell's study, the results obtained in the comprehension test were not influenced by the students' preference for global or local strategies.

We think that there are several reasons for the absence of significant correlation between the students' metacognitive knowledge about strategies and their comprehension performance. One is that the reading comprehension test may have not been difficult enough to be relevant of the level of comprehension of the students, because, as we saw, most of the subjects understood the text and when we analysed the profile of each of the clusters, we observed that the mean scores on the reading comprehension test were similar in the clusters. Related to this is the belief that a reading comprehension test may not be enough to measure the subjects' reading performance and the relationship between awareness of reading strategies and reading performance must be studied on a wider variety of reading tasks.

We observe a general preference for local strategies, corroborated in the more specific cluster analysis. This preference may be explained by the fact that our students have confusing ideas about themselves as learners, that they know very little about different strategies and about their potential effectiveness.

One of the most important practical results of our study is the information it offers about foreign language students' awareness of reading and reading strategies. This information is especially important in our attempt to help our students in their learning, so that they become autonomous learners able to identify needs and set objectives in accordance with their goals, and able to evaluate and monitor their progress over time.

The next step is to help them learn about their learning styles and preferences and about their beliefs and expectations about language learning in general and about strategies for reading in a foreign language in particular.

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## APPENDIX I

### METACOGNITIVE QUESTIONNAIRE

The following statements are about silent reading in English. Please indicate the level of your agreement or disagreement with each statement by circling the appropriate number: 1 indicates strong agreement, 5 indicates strong disagreement.

1. When reading silently in English, I am able to anticipate what will come next in the text.....
2. When reading silently in English, I am able to recognize the difference between main points and supporting details.....
3. When reading silently in English, I am able to relate information which comes next in the text to previous information in the text.....
4. When reading silently in English, I am able to question the significance or truthfulness of what the author says.....
5. When reading silently in English, I am able to use my prior knowledge and experience to understand the content of the text I am reading.....
6. When reading silently in English, I have a good sense of when I understand something and when I do not.....

When reading silently in English, if I don't understand something,

7. I keep on reading and hope for clarification further on.....
8. I reread the problematic part.....
9. I go back to a point before the problematic part and reread from there.....
10. I look up unknown words in a dictionary.....
11. I give up and stop reading.....

When reading silently in English, the things I do to read effectively are to focus on:

12. mentally sounding out parts of the words.....
13. understanding the meaning of each word.....

14. getting the overall meaning of the text.....
15. being able to pronounce each whole word.....
16. the grammatical structures.....
17. relating the text to what I already know about the topic.....
18. looking up words in the dictionary.....
19. the details of the content.....
20. the organization of the text.....

The best reader I know in English is a good reader because of his/her ability to

21. recognize words.....
22. sound out words.....
23. understand the overall meaning of a text.....
24. use a dictionary.....
25. guess at word meanings.....
26. integrate the information in the text with what he/she already knows.....
27. focus on the details of the content.....
28. grasp the organization of the text.....

## **APPENDIX II**

### **TEXT**

#### **WATER-BASED HYDRAULICS**

Hydraulic power was first based on water. The development of the oil industry meant the ready availability of power transmission fluids with improved characteristics compared to water. Oil has better lubrication ability and increased viscosity which allowed much higher contact loads to be achieved in the machinery as well as lower leakage rates.

Water-containing hydraulic fluids have evolved since the late 1940s in response to the fire ignition risks of oil systems. The safety concerns of the steel, mining, and offshore users have played a major part here.

Initially, these fluids were 40/60 water/oil mixture but these have been progressively modified into the 95/5 systems available today. High water-based fluids have to contain additives so that internal components relying on metal upon metal contact can operate without excessive wear.

Water-powered machinery with its inherently non-polluting media is a very attractive prospect especially because of environmental concerns about the con-

sequences of oil leakages and the disposal of oil residues. In order to engineer effectively for water power, the following points need to be considered:

— Water lacks boundary lubrication. When oil is used as a hydraulic fluid, it provides lubrication and reduces corrosion. Machinery can operate with some rubbing contact without excessive wear. When water is used, component surfaces in sliding contact should be made of corrosion-resistant non-metallic materials such as ceramics or polymers.

— Water has low viscosity. Sealing is more difficult.

— Corrosion. Metals are significantly affected by water. The use of corrosion preventing additives or non-corrosive materials is advised.

— Contamination. Using 'raw water' such as sea-water which contains significant amounts of particles and salinity can cause wear and corrosion. Filtration may be necessary.

P. Tweedale «Beating the fire risk with Water Based Hydraulics», *Professional Engineering*.

## COMPREHENSION QUESTIONS

1. Why is oil superior to water as a hydraulic fluid?
2. Why were water-containing fluids developed?
3. How can the wear of metal parts be reduced in water-based hydraulic equipment?
4. What materials should be used where possible for component surfaces in sliding contact?
5. Why is sealing difficult with water-containing fluids?
6. Why is filtration of sea-water advised?