Evaluation of a Web-Based Training System

for reading scientific documents based on activating visual information

Yukari Kato and Toshio Okamoto
Tokyo University of Agriculture and Technology, Nakach, Koganei, Tokyo, Japan
The University of Electro-Communications, Chofugaoka, Chofu, Tokyo Japan

Abstract: This study investigates the conditions under which graphical information can support reading comprehension in a second language. This paper presents results of an experimental study in which reading comprehension of foreign students in two different environments was compared: vocabulary learning only vs. vocabulary and grammar plus graphic tasks. The results indicate that tasks decreasing grammatical complexities were more effective than lexical practices.

Keywords: Web-based training, Japanese for Specific purposes, academic reading, graphical information.

1. INTRODUCTION

In recent years in Japan, there has been a rapid increase in numbers of foreign students studying at science and technology graduate schools. These students have already completed some academic courses in their major fields, but do not have language ability sufficient for academic life in Japan. In order to integrate such students into their language environment, language institutes and international student centers provide intensive language courses and arrange tutoring programs. For foreign students at science and technology universities, however, there is little time to enrol in regular Japanese language courses or to utilize available language learning opportunities.

To solve these problems, many universities and institutions have developed web-based language learning support systems that are free and open to all users. Most web-based systems are limited to automatically displaying the meaning of unknown words and the structure of each sentence by using morphological and syntactic information. Non-native readers use these systems mainly to decrease the time needed to look up

unknown words in a dictionary. The validity of these systems has not been supported by language learning theories and psychological research.

In the fields of pragmatics and cognitive linguistics, there has been a renewed interest in "Relevance Theory" as proposed by Sperber and Wilson (1986). Sperber and Wilson (1986) assume that complex communication combines two different modes: *the coding-decoding mode* and *the inferential mode*. Based on this hypothesis, linguistic coding and decoding might involve the use of coded signals that fall short of fully encoding the communicator's intentions and merely provide incomplete evidence about them. In other words, communication is successful not just because readers are able to recognize the linguistic meaning of the author's arguments, but because readers also infer the author's true purpose in using them. Therefore, a *coding–decoding* process should be subservient to the *inferential* process (Silberstein, 1994).

Silberstein (1994) suggests that readers practice interpreting the function of various graphics, so that they can respond to them quickly and appropriately. However, it must be noted that the significance of the graphics is interpreted and explained only within the text (Moriarty, 1996). Therefore, readers need to understand not only individual details, but also the relationship among ideas for thorough comprehension of academic articles (Silberstein, 1994). Therefore, it is necessary to develop a relevant learning environment to manage the integration between graphical and textual information for academic reading comprehension.

So far, we have presented the hypothesis of communication proposed by Sperber and Wilson (1986). Based on their relevance theory, we shall later discuss our framework for a relevant learning system. Through implementing instructional devices based on the *Relevant Language Learning Framework* (Kato et al. 2002), this study provided empirical data used to identify factors that influence use of graphical information. The purpose of this framework is to propose a general guideline for Japanese language learning through use of experimental and theoretical data to identify information relevant to academic reading comprehension. According to the *Relevant Language Learning Framework* (Kato et al. 2002), four different reading strategy modules (lexical, grammatical, rhetorical, and graphical) were investigated during academic reading comprehension using computer-based instruction.

This paper is organized as follows: Section 2 describes the experiment conducted to investigate the influence of courseware design on use of graphical and textual information in academic articles. Section 3 outlines a proposed instructional model, based on both experimental and theoretical principles for an effective reading support system for non-native speakers, which facilitates the use and integration of graphical and textual information.

2. EXPERIMENT

In this experiment, the efficacy of two different courseware designs was tested by elaborating four reading strategy modules in the courseware. The most important difference for facilitating graphical information in reading comprehension occurred between the two grammatical and lexical modules.

2.1 Research Questions

The question at hand is whether courseware based on the *Relevant Language Learning Framework* (Kato et al. 2002) can facilitate reading comprehension in foreign students. Two types of courseware design were used to examine interaction between graphical modules and three strategic modules (lexical, grammatical, contextual). Two types of measurements (assimilative and discriminative questions) were used for reading comprehension. The following questions were investigated:

1. *How does the grammatical and lexical module influence graphical information use in the assimilative process of reading comprehension?*
2. *How does the grammatical and lexical module influence graphical information use in the discriminative process of reading comprehension?*

2.1.1 Subjects

The experimental subjects were 12 foreign students studying at national and private universities in Japan: 6 graduate students and 6 undergraduate students, including both intermediate and advanced learners of Japanese. Most participants had already received 1-2 years of formal instruction but were not yet able to pass the first level of the Japanese Proficiency Test. To examine the two different conditions, participants were randomly assigned to one of two courses. Five students participated in courseware A and seven students participated in courseware B:

Courseware A: (n=5; 2 undergraduates and 3 graduates)
Courseware B: (n=7; 4 undergraduates and 3 graduates)

2.1.2 Materials Structure and Procedures

Materials

We selected an article that appeared in a Japanese journal of information processing (Matsukura, 1999). The article describes advantages and disadvantages of a new meeting support system in comparison to previous meeting styles. The article had been used in prior research concerning the effects of graphical information on reading comprehension (Kato et al. 2001).

Design and Procedures

Two types of courseware design were used to examine the interaction between four reading strategies. They shared the following similar constructions: 1) pre-question, 2) reading strategic modules, and 3) reading passage with two types of reading comprehension tests.

Participants were tested individually on web-based courseware on the Learning Management System (http://conery.ai.is.uec.ac.jp). Each participant read the reading passages with strategic tasks and completed the assimilative and discriminative tests online. The access logs and participant scores were recorded on the WebClass server.

In the first section (pre-question) of the courseware, participants answered a questionnaire aimed at determining lexical knowledge related to the reading passage.

In the second section (reading strategic module), there was an important difference between the two coursewares on the weight of reading strategic lexical practices.

In courseware A, participants only answered a 27-item vocabulary quiz lexical module. In contrast, in courseware B, participants completed four strategic tasks: (a) vocabulary quiz (10 items), (b) grammar practice (9 items), (c) information transfer activities between graphical and textual information (3 items), (d) paraphrasing to identify main idea of discourse (5 items). Figure 1 shows examples of (c) information transfer activities.

In the third section, two types of measurements (assimilative and discriminative questions) were used to assess reading comprehension. Assimilative questions were prepared to examine immediate aspects of understanding (Widdowson, 1978). Thus, they involve the realization of prepositional and illocutionary value by reference to what has proceeded. Discriminative questions were also prepared in order to facilitate conveyance of the main message. They deal with relative significance, enabling us to take notes and write summaries.

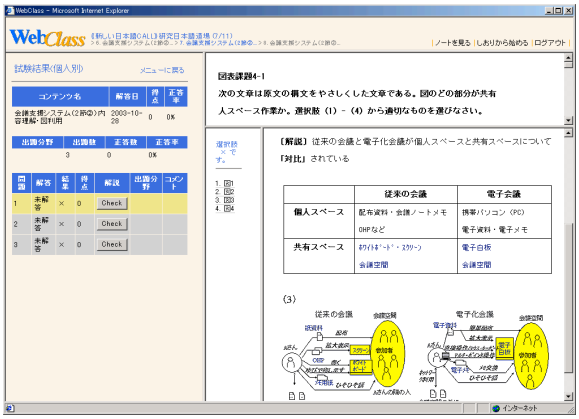

Figure 1: Information-Transfer Modules

3. RESULTS

We conducted two types of reading comprehension tests: assimilative and discriminative. The experiment aimed to examine the relationship between graphical modules and three strategic modules (lexical, grammatical, and contextual).

3.1 Correlation Analysis of Assimilative Questions

The lexical scores on pre-questions were positively related to the total scores on assimilative questions (r = 0.63). The correlation matrices reported in Table 1 were computed for each of the seven participants in courseware B. As predicted, the scores on both grammar and graphical modules were positively related to the scores on assimilative questions. Table 1 shows the strong relationship between grammar modules and graphical modules.

Table 1: Correlation Matrices for Strategic Modules and Assimilation

	Lexicon	Grammar	Graphic	Context	Assimilation
Lexicon	1.00				
Grammar	0.69	1.00			
Graphic	0.60	0.96*	1.00		
Context	0.86	0.32	0.20	1.00	
Assimilation	0.60	0.89*	0.96*	0.32	1.00

*p < .05

3.2 Analysis of Discriminative Questions

Participants in both coursewares A and B first summarized the main idea and then completed multiple-choice questions. The descriptive data from the summaries was analysed using a rubric developed to score the accuracy of relational meaning to written arguments (Muramono, 1992; Kato et. al. 2003):

1. Systematic/Central Conception; accurate structural knowledge with complete and accurate connection.
2. Partial/Peripheral Conception; structural knowledge with complete and accurate connection.
3. Duplicate Conception; at least one accurate structure shown, but connections between structures are inaccurate or missing.
4. Irrelevant; structural knowledge shown is inaccurate and irrelevant.

The rubric broke summary sentences into four categories of central, peripheral, duplicate, and irrelevant as shown in Table 2. In this coding system, central concepts were seen as more desirable than a mere listing of individual peripheral and duplicate concepts. The results, listed in Table 2, revealed that participants studying in courseware B indicated more central concepts than those in courseware A. This is especially noteworthy in the

case of high-scored participants in assimilative tests. The opposite conclusion would hold for low-scored participants, which did not show the difference in discriminative tests.

Table 2: Summary Evaluation

Participant	Nationality	Assimilation	Characters sentences	Cen	Parti	Du	Irrel
A-5	Taiwan	23%	20（1 sen）	0	0	0	1
A-1	Taiwan	55%	203（4 sen）	0	0	4	0
A-2	China	77%	127（3 sen）	0	3	0	0
A-4	Taiwan	88%	97（2 sen）	1	1	0	0
A-3	Australia	100%	107（4 sen）	0	1	0	2
B-2	Indonesia	30%	197（3 sen）	0	1	0	1
B-3	Thailand	66%	15（1 sen）	0	0	0	1
B-4	China	77%	12（1 sen）	0	0	0	1
B-1	Indonesia	77%	96（3 sen）	1	0	2	0
B-5	Korea	88%	97（2 sen）	1	0	1	0
B-6	China	88%	90（2 sen）	0	1	0	1
B-7	China	88%	83（2 sen）	1	0	1	0

Note: 204 (4 sen) = 204 characters in 4 sentences, Cen: central, Part: Partial/Peripheral, Du: Duplicate, Irrel: irrelevant

4. DISCUSSION

Kato et al. (2001) suggested that illustrations embedded in articles appear to retard comprehension in the less skilled group although they enhanced comprehension in the group of superior ability. This drives us to the question of how graphical information can be made effective for academic reading. The central issue is identifying the knowledge necessary to understand the purpose and function of typical graphical information in academic articles.

Concerning the first research question, scores on both grammar and graphical modules were positively related to scores on assimilative questions. Analysis of courseware B indicates a strong relationship between grammar and graphical modules. This result suggests that grammatical knowledge can facilitate use of graphical information, in turn promoting assimilative understanding of written arguments. This implies that grammatical knowledge plays an important role in students' ability to use graphical information and in understanding descriptive ideas in arguments.

Concerning the second research question, the greatest difference in performance on use of graphical information between courseware A and B students manifested itself in grammatical information rather than lexical information. This appears to be because grammatical information is closely related to graphical facilitation for high-scored participants, which could promote understanding of main concepts.

From the viewpoint of language teaching, focusing on familiar graphical materials may furnish opportunities to capitalize on previous knowledge

(Silberstein, 1994). On the other hand, in order to use textual information adequately, it is possible that considerable knowledge of grammatical features is required.

5. REFERENCES

Kato Y. et al. (2001). "Analysis of the strategic activation of visual information in academic reading comprehension", Japan Educational Technology, Vol.25, Supple. pp. 155-160.

Kato Y. et al. (2002).A relevant learning framework for nonnative speakers: a proposal for integrating textual and graphical information in Japanese academic reading, Information and Systems in Education, Vol.1, pp. 70-79.

Kato Y. et al. (2003). The standards for texts comprehension based on discourse-structure analysis: comparison of summary between Japanese students and foreign students, The Journal of Japanese Language Education Methods, Vo1, pp. 43-44.

Matsukura, R., Watanabe, S., Sasaki, K. and Okahara, T. (1999).A study of face-to-face collaboration support system composed of mobile PCs, Information Processing Society of Japan Journal, Vol. 40, pp.3075-3084.

Muramoto, T. (1992) Variation of Summary, Japanese Journal of Educational Psychology, Vol.40, pp.213-223.

Silberstein, S (1994). Techniques and Resources in Teaching Reading, Oxford, University Press, Oxford, U.K.

Sperber, D. and Wilson D. (1986). "Relevance", Blackwell, Oxford, U.K.

Widdowson, H.G. (1978). "Teaching Language as Communication", Oxford: Oxford University Press.