Vocabulary Learning Environment with Collaborative Filtering for Support of Self-regulated Learning

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Abstract. This study elucidates issues related to using online vocabulary learning environments with collaborative filtering and functions for cognitive and social learning support in learner-centered learning, which requires learners to be self-regulated learners. The developed system provides learners with a vocabulary learning environment using online news as a test installation of functions. The system recommends news to each learner using a collaborative filtering algorithm. The system helps learners to use cognitive and social learning strategies such as underlining, along with a word-meaning display based on the learner's vocabulary proficiency level. We investigated effects of the system on perceived usefulness and learning performance as a formative evaluation. Learners regarded this system as a useful tool for their language learning overall, but rated several functions low. Confirming the learning performance, the learner's vocabulary proficiency level improved significantly.

Keywords: Language learning, Educational technology, Learning strategies, Aptitude treatment interaction, Collaborative filtering.

1 Introduction

Concomitantly with the advancement of information communication technology, interest in using online learning environments for language learning has grown. Nevertheless, learners must be self-regulated when using learner-centered learning environments without instructors, such as online learning. Self-regulation is an important factor in successive language learning [1]. That is particularly true in Japan, where Japanese people have few opportunities to communicate with foreign language speakers. Consequently, a common topic is how to support online learning activities to foster self-regulated learners.

For self-regulated learners, the effect of the online language learning environment on learning performance is limited because this environment specifically includes self-regulated learners [2]. It is apparently difficult for non-self-regulated learners to continue to learn foreign languages in an online language learning environment. Therefore, learning activities can be supported based on three points of view: cognitive learning strategies, motivation, and social support.

J.D. Velásquez et al. (Eds.): KES 2009, Part II, LNAI 5712, pp. 523–530, 2009.

First, cognitive learning strategies directly promote understanding of the learning objective. Promotion of the use of cognitive learning strategies is apparently effective for the support of self-regulated learning [3]. However, instruction about learning strategies in a face-to-face classroom environment blended with online learning [4], and socio-affective strategies such as pair learning [5] are mainly conducted because improvement and research related to language learning specifically emphasizes face-to-face instruction. Consequently, it is necessary to develop functions in online language learning environments for the use of cognitive learning strategies.

Secondly, motivation is a central factor in successive learning. Especially, potential problems related to motivation arise in online learning environments. One is connected with the learning materials themselves. In language learning, input information such as learning material has a strong effect on learning performance [6] and motivation [7]. Input means written or spoken information in the target language that the learner can comprehend (e.g. [6], [8]). It is useful to refer to aptitude treatment interaction (ATI) for learning contents and system development. Actually, ATI signifies the interaction effect of learner's features and learning contents on learning performance, i.e., the effect of learning materials depends on the learner's independent features such as the learner's level, learner's interest, and hobbies [9]. Learning support considering ATI is apparently effective on learning performance and on the enhancement of learners' motivation. It is difficult for an online learning environment to provide appropriate learning materials to each learner because teachers must prepare learning materials conforming to each learner's prior knowledge and preferences. The other factor is related to isolation. Learners tend to be isolated in an online learning environment, apart from the face-to-face classroom. In this situation, learners share and receive little information and feedback that is usually effective for promotion of learning from the social affective and learning consciousness perspectives [10]. This lack of feedback inhibits learners' motivation. Communication tools such as Bulletin Board Systems are often added to online learning environments to solve this problem, but few learners use communication tools because of the lack of context in which to use them.This study is intended to develop English news distribution systems for English vocabulary learning, considering the enhancement of self-regulated learning from the viewpoints of self-experience and social assistance, which facilitate self-regulated learning processes [11]. We evaluate this system from the viewpoints of learners' perceived satisfaction and learning performance as a formative evaluation phase.

2 System Development

2.1 System Architecture

This system is a client/server system. Clients include software allowing the support functions of cognitive learning strategies, and communication for social learning support among learners. Client software was developed using Asynchronous JavaScript and XML (AJAX). The server side includes software for English news distribution, in addition to storage of learners' use of the support function of cognitive learning strategies. These functions in software are implemented mainly in JAVA, and partially PHP (news scraping). The server system works on an Apache 2.0 web server with the PHP module, and a JBoss application server 3.2.7. PostgreSQL 8.1.4 was used as a database server.

2.2 System Functions

This system includes three components for learners to learn vocabularies through encouragement of self-regulated learning. They are respectively designed for

(1) promotion of use of cognitive learning strategies,
(2) aptitude treatment interaction (ATI), and
(3) support of active interaction and feedback between learners.

The use of cognitive learning strategies such as underlining and motivating with learning materials in which learners have an interest are reportedly effective for fruitful learning experiences [3]. This study first designed and developed underlining, meaning display and word-memorizing functions for support to use cognitive learning strategies (elaborating by highlighting and using dictionary). The underlining function enables a learner to underline sentence(s) or word(s) when the learner finds it important for their learning or interest. Regarding meaning display, this system displays a word meaning when learners put a mouse cursor over an underlined word. The number of words displaying meaning depends on the learner's vocabulary level judged according to The Japan Association of College English Teachers (JACET) vocabulary level, which is a standardized vocabulary level measurement for English learners over college level. The word-memorizing function enables learners to make lists of unknown words. When a learner finds an unknown word, the learner can make such a list by clicking the word. This system records the word and news headers that learners have read.

The second component is used for motivating learners by providing appropriate learning materials, considering ATI. To do so, we implement collaborative filtering for the provision of learning materials along with the learner's interest. Collaborative filtering is an algorithm for the recommendation of information. The system with added collaborative filtering predicts a user's preference based on analyses of a similar user's preference. A collaborative filtering algorithm first finds similar users. Collaborative filtering has various ways to find similar users. An important way to find similar users is to use the correlation rate between users in a preference pattern. Users who have a high correlation rate are regarded as similar users to active users.This study used the "GroupLens" algorithm [12], which is a representative algorithm based on a memory-based approach, for collaborative filtering. This system predicts an active learner's interest in an unread article, calculating Pearson's correlation coefficient using similar users' rating data for read articles. This study is intended to examine the practical use of collaborative filtering in educational settings. Therefore, a simple design and algorithm are preferred for our future research, although many researchers suggest an improved algorithm [13],[14]. Therefore, we used the "GroupLens" algorithm as a test installation.

The last function related to interaction among learners aims to motivate learners to understand the content and active feedback. White (2003) suggests that social learning support such as feedback among learners affects the promotion of self-regulated learning. After the active learner clicks a news reader icon, this system shows news readers each article and an article list of news that readers have already read. Furthermore, learners can comment on each article. This function seems to reduce isolation and encourage readers to read articles, being aware of similar learners. The system interfaces are displayed in Figs. 1 and 2.

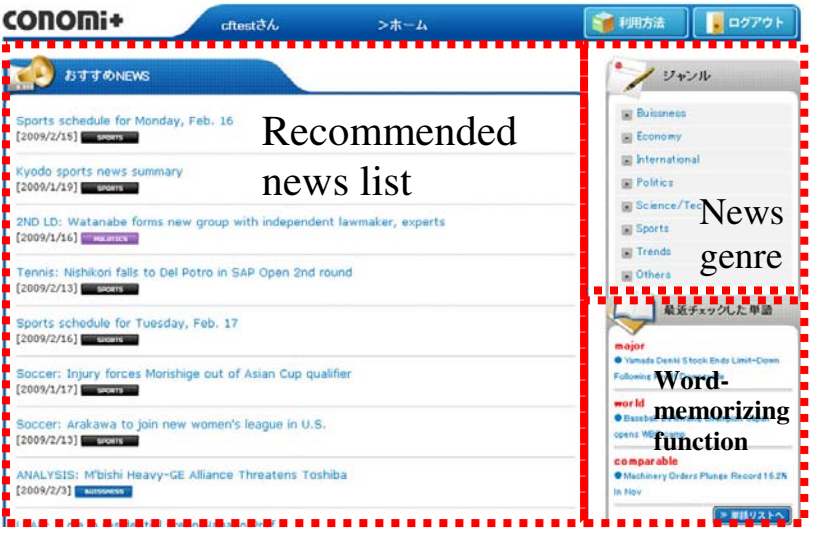

Fig. 1. Interface of top page (displaying recommended news header)

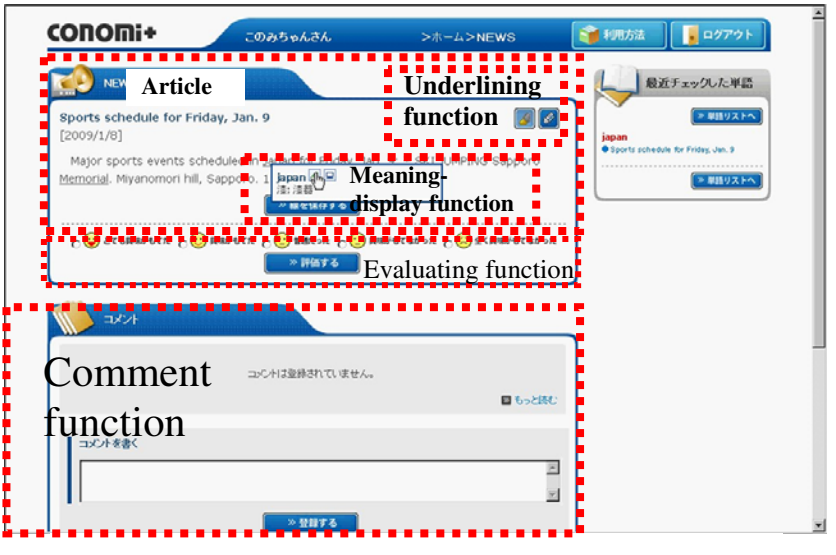

Fig. 2. Word meaning display

3 Methodology

3.1 Subjects

The subjects in this study were 235 university students. All subjects were non-native speakers of English. Of them, 132 subjects were prospective employees of the same company. Of the 235 students, 91 subjects were asked to read and rate the degree of interest in article content every day to support collaborative filtering. Therefore, data of 132 subjects were analyzed in this study for evaluation of this system. The subjects' proficiency in English varied from that of low-level students, who had difficulty in reading short passages, to that of high-level students who had studied English education. All subjects had reached at least a high school standard level in grammar and vocabulary. Because of privacy rules of the company, information about subjects was not provided.

3.2 Procedure

In all, 132 subjects were asked to use this system voluntarily for one month. First, 132 subjects were asked to take a vocabulary test (JACET test) to find a suitable assistance level to display the word meaning, and to evaluate the system's effects. Each subject accesses and uses this system whenever and wherever they want to. An online help file was uploaded on this system because of the lack of opportunity to meet subjects through this term. After one month, subjects were asked to answer questionnaires about their satisfaction with articles and the system's usability. Finally, we asked 132 subjects to take the JACET vocabulary test again.

3.3 Data Collection

This study investigated the contribution of functions to learning performance as formative evaluation. Data were collected in two ways. The first is a questionnaire. All subjects were required to answer a questionnaire after the experiment. The questionnaire asked all subjects to rate the perceived satisfaction with quantities of distributed articles, the degree of interest in article contents, and the degree of perceived helpfulness of each function from a 5-point rating scale.

4 Results

4.1 Perceived Effect and Usability of This System

In all, 56 learners answered the questionnaire. Table 1 presents the number of subjects who rated the degree of perceived effect and usability in each item. The results revealed that this system was apparently effective on their learning and the perceived satisfaction overall. Items related to a learner's interest in news ("This system did not recommend articles in which I have an interest", and "There is no genre that I wanted to read") were rated as effective. Regarding the evaluation of functions, the meaning display function and comment function were rated highly, but the underlining function was not evaluated positively. Learners felt burdened by rating their interest in each article, which plays an important role in predicting learners' interest based on responses of similar learners.

Table 1. Results of the perceived effect of this system

	Strongly agree	Agree	Neither	Disagree	Strongly Disagree
The quantities of recommended news are suitable for me	2	24	11	17	2
I had interest in news recommended by this system	4	19	19	13	1
This system did not recommend articles in which I have an interest	3	16	18	19	0
There was no genre that I wanted to read	2	10	13	25	6
It was troublesome to rate the degree of interest in news	2	19	8	19	8
I did not rate interest in news, but I read it	6	18	6	13	13
It was helpful to use meaning display function for reading the article *1	13	23	10	8	0
The word-memorizing function assisted your learning *2	1	22	18	10	1
The underlining function assisted your learning *3	3	14	21	7	3
Comments from other learners on articles were helpful to comprehend article content	7	21	17	8	3
I learned English, thanks to this system	5	32	14	5	0

*1 Two learners did not use this function.
*2 Four learners did not use this function.
*3 Eight learners did not use this function.

4.2 Learning Performance

We conducted a vocabulary test (JACET test) for evaluation of learning performance. In all, 64 learners took both a pre-test and a post-test. To do so, learners took the JACET test before and after the evaluation term. We calculated each learner's JACET

Table 2. JACET test

	Mean	S.D.		
Pre-test	4.18	2.37	$t(63)=3.35$	$p<0.01$
Post-test	4.89	2.42		

level from pre and post JACET test scores; then a paired *t*-test was conducted on the JACET level in the pre-test and post-test. Results of a paired *t*-test are presented in Table 2. Results show that this system improved the learners' vocabulary proficiency significantly.

5 Discussion

Overall, this system seemed to contribute to learners' motivation for learning, and to learning performance. The effect of meaning display, word-memorization, and comment functions on their learning were positively recognized overall, according to the questionnaire results. In particular, the comment function allows learners to comment on the text area in their native language, which facilitates communication between learners and understanding the article. However, two problems were revealed in this formative evaluation. First, collaborative filtering did not work well because of the lack of rating data for articles. The questionnaire results revealed that learners felt that rating the interest in articles was bothersome. This problem can hinder or prevent collaborative filtering. For predictive accuracy, collaborative filtering uses a large amount of rating data to detect learners who are similar to active learners.

Second, the usefulness of underlining functions was rated as less positive. Learners who answered "neither" accounted for a large share of all learners who answered questionnaires. This function was designed based on learning science and psychological theories. However, this function enabled learners to use learning activities. Learners might not use the objective to use these functions.

6 Conclusion and Future Works

This study is intended to develop an English news distribution system with collaborative filtering for English learning, and to evaluate it as formative evaluation. Overall, this system was recognized as a useful tool for English learning. In fact, positive results were revealed in the perceived usefulness of system functions and in learning performance. However, this study revealed several problems. One is the dearth of rating data, which are necessary for effective collaborative filtering. The other is the relation between functions and learning objectives. Learners were apparently aware of using some functions such as underlining and word-memorizing functions. These functions, based on learning theories, should be designed such that learners can understand how to use them to support their own learning.

Future works aimed at realization of suitable learning environments are recommended as follows.

(1): Implementation of a bridge function between the underlining function and comment function

Results of this study indicate that the effects of underlining and word-memorizing functions on learning were unclear. The system must enable learners to be aware of the purpose of using these functions. One way seems to be connection of these functions to comment functions to facilitate social support.

(2): More elaborate analysis
To determine the effect of this system on learning, comparative analyses will be conducted using low-frequency and high-frequency groups, and groups which are less and more familiar with the recommended articles. In the next phase, we will add analyses of self-regulated learning such as the continuance rate and school behaviors.

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