

# Dynamic Term Suggestion for Searching Multilingual School Documents

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**Abstract.** The number of school children having ties overseas is on the rise year after year in Japan. In order to support these children and their parents, we developed a multilingual school document portal site, and made it open to the public. The portal site allows easy-to-use document retrieval by faceted classification as well as keyword search. However, it is not necessarily easy for the users to express their information needs in query terms, and they often come up with poor results from short and generic query terms. In pursuit of the formulation of better query statements with a few search terms even in the initial query, we realized a dynamic term suggestion or auto-suggest interface in the portal site. In the auto-suggest interface, suggested terms are ranked according to domain relevance, rather than merely on the basis of term occurrence frequency in the document collection. In this paper, we explain an overview of the school document portal site, the auto-suggest interface realized in the portal, and the domain-dependent term-weighting scheme, followed by the results of a user study conducted to demonstrate the effectiveness of the auto-suggest function.

**Keywords:** Auto-suggest, dynamic term suggestion, faceted search, domain vocabulary, multilingual school document, portal site.

## 1 Introduction

The number of residents having ties overseas is on the rise in Japan, and currently, more than twenty-five thousand children, who do not speak Japanese as their mother language, live in Japan. According to a survey by Ministry of Education, Culture, Sports, Science and Technology in 2008 [1], the top three foreign languages (i.e., Portuguese, Chinese, and Spanish) to be supported in Japanese school constitute 72.9% of the total number of school children whose mother language are not Japanese. In addition to these top three, the top seven languages, which include Filipino, Korean, Vietnamese, and English, constitute 94.1% of the total number [2]. In schools that accept pupils with international background, it is widely known that to overcome the difficulty of communication

between teachers and guardians is crucial, and to solve the shortage of appropriate support for specialist subjects for pupils without enough command of Japanese are needed.

Multilingual school documents are parallel text written in multiple languages, and used by school teachers for pupils and their guardians. Such school documents are made for meeting various educational needs: notification of school activities, inquiry about health condition, financial notices, immigration procedures, and so on. A number of school documents are made available as downloadable files through Web sites of institutions such as extra-government organizations, prefectural boards of education, and nonprofit organizations. Those school documents are, however, maintained individually and separately in each Web site. Therefore, it is not easy for the teachers to obtain a desired document from the results of general-purpose search engines, which include all the related pages as well as document links relevant to the search terms.

In order to facilitate sharing and distribution of such school documents, we have developed a multilingual school document portal site [3], which collects over 1,200 links to existing multilingual school documents of twelve languages. The school document portal<sup>1</sup> has been made open to the public since Oct. 2009. The development of the portal site has been conducted as part of the Project MUSE (Multilingual Support for Education) that aims at the deployment of multilingual educational support tools and resources (e.g., educational materials, vocabularies, and documents) through the Web [4].

The school document portal site is realized as a faceted navigation system that allows users to explore a collection of information by using a number of orthogonal attributes or facets [5,6]. Since it is often not easy for the users to fully narrow down a scope of information solely with predefined facet values, this portal site allows the users to perform keyword search as well. However, it is not necessarily straightforward for the users to express their information needs in query terms, and they often come up with poor results from short and generic query terms [7]. It is pointed out even searchers well-acquainted with a target domain relies on objective information such as names of authors, projects, and article titles [8]. It is also reported that the mean number of search terms in a Web search query is marginally above two for both general-purpose search [9] and domain-dependent Web site search [10].

Therefore, in order to help searchers formulate better query statements with a few search terms, it is helpful for the searchers to be suggested query terms as early as possible even during the initial query, rather than after they received the search results. Such dynamic term suggestion is sometimes referred to as auto-suggest [11]. Variations in the auto-suggest feature can be categorized roughly into four types according to their domain-dependence of search range (i.e., general purpose vs. domain dependent) and granularity of term completion (word level vs. character level). By the word-level suggestion, it means that an incomplete word cannot be expanded to be a full spelled word by the system assistance, but the users need to type a word in full before the system

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<sup>1</sup> <http://www.tagengo-gakko.jp/bunsho/> (in Japanese).

suggests additional words or phrases. Auto-suggest interfaces are already available in practice for general-purpose search engines with character-level completion (e.g., Google Suggest and Yahoo Search Assist), and a log-based longitudinal study provides evidence that auto-suggest interfaces are rapidly prevailing [12].

Despite the increasing presence, there has been little user study on the effectiveness of auto-suggest interfaces [11]. There is a case for the word-level completion with a general-purpose search engine [15]. In the experiment, the participants made positive comments on the interface in the questionnaire, but there was no statistically significant difference between the cases with and without auto-suggest in terms of the users' search time<sup>2</sup> and quality of results [15].

The auto-suggest interface we developed for the document portal falls into the type of the character-level suggestion for domain-dependent search. In this interface, the suggested terms are ranked on the basis of a term-weighting method that takes into account the domain vocabulary as well as entropy of topic in the topic classification scheme created for the school document portal. In this paper, we describe a user study to demonstrate the effectiveness of the domain-dependent auto-suggest interface considering the cases without auto-suggest and domain vocabulary. The remainder of this paper is organized as follows. The school document portal site is briefly introduced in the next section, and the section 3 explains the auto-suggest interface integrated with the search box of the portal. The section 4 presents the evaluation method, and finally the results of evaluation and our findings are given in the section 5.

## 2 Multilingual School Document Portal Site

Multilingual school documents are composed mostly of parallel texts line-by-line in both Japanese and a target language. Figure 1 shows an example of a school document. Most school documents are created separately for each language by translation staff members, and handed out from a class teacher to foreign children to notify school activities and schedules to their parents/guardians. The school document portal site as a faceted navigation system allows users to find items on the basis of multiple aspects or facets, instead of forcing the users to view items from a single classification hierarchy.

As shown in Figure 2, the top page of the portal site<sup>3</sup> displays several facets that characterize multilingual school documents: topic, language, file type, and area of document owning institution. For example, if a school teacher needs to prepare a document of health checkup prior to a school activity, which is handed out to Spanish children and expected to be available in a PDF format. The teacher as a portal user may start by selecting "Spanish" from the language

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<sup>2</sup> Since the user interface was not responsive taking 1.8 seconds on an average until the suggested terms were displayed [15], the benefit of the auto-suggest interface was not be fully utilized in the experiment.

<sup>3</sup> The school document portal is currently afforded to Japanese school teachers, and the site in itself is available only in Japanese. The screen copies in this paper are translated in English for the explanation purpose.

	平成 年 月 日 Date / /
保護者 様 Dear Parents,	市立 小学校 校長 Municipal Elementary School Principal
就学时健康診断のお知らせ <b>School Entry Health Checkup</b>	
就学时健康診断を下記のとおり実施いたします。入学予定のお子様とご一緒にお越しください。 やむを得ず欠席する場合は、学校へ連絡してください。	
The health checkup for children starting school is scheduled as follows. Please come to the place indicated below with your child. If you cannot come due to unavoidable circumstances, be sure to contact our school.	

**Fig. 1.** Portion of a multilingual school document

facet, and will be presented immediately with Japanese titles of documents with translation in Spanish. Further selection of "Pre-event health checkup" from the topic facet eliminates options in unspecified facets. The file-type facet in this situation only presents file types available under the current conditions, namely, the ones for Spanish parallel documents classified in the selected topic.

In the course of facet-value selection, the user can see a list of documents that meet the specified conditions. If the user further selects "PDF" from the file-type facet, the portal shows titles of documents available in PDF format, whose topic is "Pre-event health checkup" (Figure 3). Note here that the retrieved documents are links collected from different institutions across the country. The area-of-owning-institution facet in the lower left of Figure 3 indicates that the currently listed ten documents come from the three prefectures. In this way, the faceted navigation allows the users to elaborate the facet-value selection progressively, making sure the effect of choice in a facet on the available options in the other facets. Furthermore, dynamically updating the number of available items for each facet value, faceted navigation avoids coming up with empty list or dead ends resulting from unsatisfiable combination of facet values [6].

### 3 Dynamic Term Suggestion

Since most Web users are accustomed to keyword search, it is helpful to seamlessly integrate the category-based faceted search with keyword search in the same interface [13]. In this school document portal, faceted and keyword search functions are provided in the same interface, and users can make use of them in an arbitrary order to specify requirements for desired documents. Although



Fig. 2. Top page of the multilingual school document portal site

the keyword search is easy to use and helpful, it is not necessarily obvious for the users to select terms effectively navigate the search space. By looking into the search log of the portal site, there were cases where the users typed in generic terms (e.g., *checkup*, *school*, and *communication*), which did not contribute to narrowing down the search results.

In order to help searchers improve query statements, query expansion techniques have been investigated [14]. Query expansion is to build a new or modified query by supplementing with additional terms, and can be performed manually, automatically or interactively [14]. Interactive query expansion (IQE) is a potentially useful technique to improve queries by incorporating users' decision upon the term selection. However, IQE has not often been used in operational systems due to insufficient integration with search interfaces without substantial help during the initial query formulation [15]. For instance, a real-time query expansion [15] is proposed as an extension of IQE, which allows dynamic term expansion even during the initial query formulation, but it is still less interactive because the expansion is performed only at the word level. The dynamic term suggestion we adopted here is also a sort of real-time query expansion, and more responsive due to the expansion at the character level rather than the word level.

Moreover, it is reported that subject knowledge facilitates increasing the extent and specificity of the queries made by searchers familiar with the subject, and contributes to the improvement of search effectiveness [16]. Therefore,



Fig. 3. Results of faceted search with the multilingual school document portal

domain knowledge is an important source of improving query statements. The dynamic term suggestion realized in the school document portal exploits domain knowledge, so that suggested terms can be ranked taking account of domain relevance, rather than merely on the basis of term occurrence frequency in the document collection. In the following subsections, we present an overview of the auto-suggest interface, and then briefly explain the domain-dependent term-weighting scheme.

### 3.1 Auto-Suggest Interface

Figure 4 shows a prototype<sup>4</sup> of auto-suggest interface realized in the search box of the school document portal. While the user is typing a term, the interface presents a list of suggested terms after every keystroke. The term expansion is automatically executed once the user starts keystroking for every 500 milliseconds. The suggested terms are shown in the drop-down list, and include compound terms expanded by partial matching with what has been typed so

<sup>4</sup> The interface is currently integrated only for the experimental use, and is not available in the public release.

けんこう		
タイトル: けんこう (16個の候補)		
健康診断	63件	1. medical examination
健康保険証	7件	2. health insurance card
健康相談	5件	3. health counseling
就学時健康診断	19件	4. pre-school medical checkup
健康状態	37件	5. health condition
健康調査	36件	6. medical checkup
定期健康診断	23件	7. regular health checks
健康管理	26件	8. health management
就学時健康診断の結果	5件	9. pre-school medical checkup results
健康	134件	10. health
すべての候補を表示		

(a) Terms suggested with domain vocabulary

けんこう		
タイトル: けんこう (3個の候補)		
けんこう	26件	1. health (in phonetic characters)
健康	210件	2. health
健康上	10件	3. health-related

(b) Terms suggested without domain vocabulary

**Fig. 4.** Drop-down lists with suggested terms on the left in Japanese, and the terms in English on the right for the explanation purpose

far. Each suggested term is displayed with the number of documents relevant to the term. When the user clicks one of the suggested terms, a query is executed and a list of document titles are given in the content area as shown in Figure 3.

The drop-down lists in Figure 4 show the suggested terms came up when the user typed *kenkou*<sup>5</sup> in hiragana or Japanese phonetic characters. If there exist more than ten suggested terms, "show all candidates" link is displayed in the lower right of the drop-down list as in Figure 4(a). All the candidate terms can be listed by vertically extending the drop-down list when the user clicks the show-all-candidate link. The terms in Figure 4(a) are suggested and ranked taking account of the domain vocabulary. They include not only narrower terms such as the first candidate *kenkou-shindan* that means 'medical examination,' but also related terms such as the second candidate *kenkou-hokenshou* that means 'health insurance card.' The dynamic term suggestion here helps the users to follow the Web search practice that is to modify queries from broad to narrow formulation via adding terms for more precision [9].

In contrast, Figure 4(b) shows suggested terms came up simply relying on generic vocabulary without regard to any domain-specific terminology. In this

<sup>5</sup> One of its possible meanings is 'health.'

**Table 1.** Number of documents classified in each topic

Topic	Number of documents
Achievement/career path	72
Announcement/request	275
Expense/benefits	85
Healthcare	351
School activities	201
Notification/certificate	87
Disaster/crime-prevention	51
Schooling system	77
Miscellaneous translations	73

case, the candidate in the list include only generic terms such as *kenkou* in phonetic characters and kanzi characters, respectively in the first and the second candidate in Figure 4(b). Differences in the variation and ranking of suggested terms come from the domain-dependent term-weighting scheme behind the auto-suggest interface, which is further explained as follows.

### 3.2 Domain Knowledge

The domain knowledge used for the auto-suggest feature has been developed as part of the project MUSE, and consists of a subject classification scheme of school documents, and vocabularies in school-education domain. The school documents in the portal site are categorized by the scheme and displayed in the topic facet shown in the upper left of Figure 2. The classification scheme for school documents was created by means of card sorting and hierarchical clustering methods, and consisted of the nine of top-level topics [3]. Table 1 shows the top-level topics and the number of documents classified into each topic in the portal site. Note that some of the topic names are composed of two (e.g., *Announcement/request*). This is because they were aggregated as a single topic name as results of hierarchical clustering, so that it can be avoided to create isolated clusters that may include only a few documents in a topic.

Besides the document classification scheme, terms in school-education domain have been collected and refined by school teachers and translation staff members participating in the project. The domain vocabulary used in this study contains 2679 terms, which includes terms related to educational activities (361 terms), school calendar (918 terms), children’s healthcare (542 terms), and so on. With reference to the domain vocabulary as well as a generic Japanese dictionary, indexing terms are extracted from Japanese sentences in the parallel translation of all the school documents, by using a morphological analyzer<sup>6</sup>. All the nouns are extracted as indexing terms from the documents, but the terms simply consist of a single (hiragana or kanzi) character are excluded as stop words. On

<sup>6</sup> <https://sen.dev.java.net/>



the other hand, compound terms in the domain vocabulary may be suggested as narrower or related terms as explained in the term suggestion with domain vocabulary in Figure 4(a). To put it another way, compound nouns in the domain vocabulary facilitate implicit use of semantic relations during the dynamic term suggestions, and provides the users with the semantic context entailed in the school documents in the portal.

### 3.3 Term Weighting

In the auto-suggest interface, the suggested terms are ranked in the order of significance. The equation (1) below is a domain-dependent metrics that exploits domain vocabulary and topic classification scheme as domain knowledge. Weight of a term  $i$  ( $W_i$ ) is calculated as arithmetic average of  $X_i$  and  $Y_i$ , which is multiplied by  $Z_i$ .

$$W_i = \frac{(X_i + Y_i) Z_i}{2} \quad (1)$$

$X_i$  here considers if a term is included in the domain vocabulary, and  $Y_i$  measures the infrequency or rarity of a term's occurrence in a subset of documents that are classified into the same topic. This is based on the assumption that the less likely a term is to be associated with topics through documents the better is it likely to be at discriminating relevant from irrelevant a subset of documents in the same topic. Moreover, the arithmetic average is multiplied by  $Z_i$  in order to reduce significance of terms that are likely to be weak in semantics and occur frequently. Further details of each term in the equation (1) are given as follows.

$$X_i = \begin{cases} A_N/I_N, & \text{if term } i \text{ is included in domain vocabulary} \\ 0, & \text{otherwise} \end{cases}$$

where  $A_N$  is the number of terms in domain vocabulary;  
and  $I_N$  is the number of terms in documents

$$Y_i = -\frac{1}{S_N} \sum_{k=1}^{S_N} \frac{D_{ki}}{D_i} \log \frac{D_{ki}}{D_i}$$

where  $S_N$  is the number of topics;  $D_i$  is the number of documents containing term  $i$ ; and  $D_{ki}$  is the number of documents containing term  $i$  and classified in topic  $k$

$$Z_i = \begin{cases} 0.5, & \text{if the number of hiragana characters in term } i \leq 2 \\ 1, & \text{otherwise} \end{cases}$$

## 4 Evaluation

The aim of this study is to investigate how effectively users can retrieve school documents with the support of auto-suggest interface as well as the domain-dependent term-weighting method. The study used a 2x2 mixed factorial design with one between-participants variable and one within-participants variable.

The between-participants variable was type of search interfaces (with or without auto-suggest). The within-participants variable was inclusion of the domain vocabulary (with or without domain vocabulary). In this section, we describe aspects of the evaluation method, beginning with the experimental system.

#### 4.1 System

In order to focus on the auto-suggest interface and control system conditions, the feature of faceted search was deactivated and only the keyword search was made available in the school document portal site. The portal site was customized into four ways in accordance with the 2x2 factorial design. The baseline system provided only the keyword search function without the auto-suggest interface, where the domain vocabulary was not included in the indexing terms and the weight of indexing terms was calculated without considering the domain vocabulary. That is, the effect of  $X_i$  in the equation (1) is nullified while  $Y_i$  and  $Z_i$  is effective. On the other hand, the full-featured system provided the auto-suggest interface, and the domain vocabulary was considered for the indexing terms and their weighting function. In the other two systems, either of the auto-suggest feature or the domain vocabulary was taken into account in addition to the baseline system.

#### 4.2 Method

**Participants.** A total of 32 undergraduate students were recruited from Faculty of Informatics, Kansai University. The participants were without prior experience of using the school document portal site, and paid to participate in the experiment.

**Apparatus.** We tested all the participants in a lab setting on the campus, using Mozilla Firefox 3 browser on Windows Vista workstations with 19-inch monitors set at 1280 by 1024 pixels in 24-bit color. The system ran on a server located in the campus, and data was recorded in the server log.

**Experimental Tasks.** Some search tasks are exploratory and requires searchers to gather information on a subject to allow them to perform some action [15]. In contrast to such an open-ended search, this portal is primarily used for seeking particular pieces of information or school documents in a target language. Therefore, a type of tasks to be investigated here is not exploratory search but known-item search [17]. The known-item search is to seek for a particular information item under the searchers' anticipation that such an item exists, and sometimes referred to as navigational queries in Web site search [18].

In this study, we suppose a situation where the school document portal is used to find out and download document files of a desired topic in a target language. Participants are asked to assume they are a teacher in an elementary school, and a situation looking for a Portuguese document that meets specified needs. Table 2 shows the descriptions of the experimental tasks presented to the participants.

**Table 2.** Descriptions of the search tasks

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T1:	In your class, some pupils need detailed tuberculosis (TB) examination. Find a document to notify that the examination is TB reaction test and direct chest X-ray.
T2:	The schedule of the open class day has been fixed. There also will be a parent/guardian meeting after classes. Find a document to notify the date and plan of the day.
T3:	Currently mass cold infections are going around the schools in the city. Find a document informing on temporary closing of class and schedule changes.
T4:	For educational purposes, school operates recycling. Find a document to bring newspapers, magazines, cardboard of no use to school.

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**Procedure.** One half of the participants were assigned to the system without the auto-suggest feature whereas another half were assigned to the system with the auto-suggest feature. In each system condition, the participants attempted the four search tasks in Table 2, where two tasks were assigned exclusively to each of the two term weighting conditions (with or without the domain vocabulary). In both systems, the task presentation order was carefully counterbalanced across participants.

The experiment was conducted in the following sequence. After answered a short demographic questionnaire, the participants were given an overview of the study and a brief explanation of the system. The participants were then asked to perform one practice task prior to the experimental tasks. For each of the experimental tasks, the participants were presented a task instruction and a sample copy of a school document that meet the requirements of the task at hand. There was no feedback from the system if the participants selected a correct document or not. This situation reflects the nature of the known-item task in the sense that the searchers need to determine whether an expected information item is actually found. In addition, the search time is limited to at most 5 minutes for each task because it is not realistic for Web users to spend more time for a know-item search task. Finally, the participants were asked to complete a short questionnaire about their experience.

## 5 Results and Discussions

In the following analyses, the level of significance was set to  $p < 0.05$  for all comparisons.

### 5.1 Search Success Rate

Table 3 shows average rates of search success achieved in the limited search time within 1, 2, or 3 minutes. In each of the search time limit, a two-way ANOVA

**Table 3.** Average rate of search success (SD in parentheses)

Time (min)	NAS		AS	
	NDV	DV	NDV	DV
1	0.09 (0.20)	0.28 (0.31)	0.22 (0.31)	0.31 (0.24)
2	0.38 (0.38)	0.63 (0.33)	0.59 (0.40)	0.69 (0.24)
3	0.56 (0.39)	0.84 (0.23)	0.84 (0.23)	0.81 (0.24)

NAS = no auto-suggest, AS = with auto-suggest,  
 NDV = no domain vocabulary, DV = with domain vocabulary.

was used to determine if there was a significant difference in the success rate between the search interface type and the inclusion of the domain vocabulary. There were significant main effects of the inclusion of the domain vocabulary in the search time limit of 1 minute [ $F(1, 30) = 4.175, p < 0.05$ ] and 2 minutes [ $F(1, 30) = 4.291, p < 0.05$ ]. In each case, the success rate was higher when the domain vocabulary was included. There was no significant interaction between the factors in both cases.

On the other hand, when the search time was limited within 3 minutes, a significant main effect was found for the search interface type [ $F(1, 30) = 4.342, p < 0.05$ ], and the success rate was higher when the auto-suggest interface was used. There was a tendency of interaction [ $F(1, 30) = 3.488, 0.05 < p < 0.10$ ] in this case. This tendency was revealed due to the considerably low success rate (0.56) in the baseline system, in which neither the auto-suggest interface nor the domain vocabulary was provided, while the success rates in the other three conditions were greater than 0.80.

According to the above results, it was demonstrated that the domain vocabulary contributed to the improvement of the success rate during the first two minutes. In contrast, the effect of the auto-suggest interface became more influential when the search time elapsed had exceeded two minutes. The rates of search success in Table 3, however, consider only the success or failure of the search. In order to further investigate the effectiveness of the search assist feature, we focus on the number of queries in each task as well as precision and recall.

It is important to note here that when the search time limit was three minutes, mean plus standard deviation of the success rate went beyond 1.0 or the maximum value in the three of the four conditions (Table 3). This situation suggests a ceiling effect that may depress averages below the true values. This effect might be present due to the relatively decreased complexity of the search task when performed for more than three minutes. In addition, when the search time was limited to one minute, the maximum success rate was 0.31. Thus the one-minute search time is too short to be considered for the assessment of the search effectiveness. In the following analyses, therefore, we take the case of the two-minute search time into account.

**Table 4.** Mean values in the case of two-minute search time (SD in parentheses)

	NAS		AS	
	NDV	DV	NDV	DV
Number of queries	3.16 (1.34)	2.16 (0.72)	1.66 (0.58)	1.41 (0.44)
Precision	0.05 (0.04)	0.13 (0.09)	0.13 (0.05)	0.19 (0.07)
Recall	0.48 (0.20)	0.66 (0.22)	0.95 (0.09)	0.72 (0.16)

NAS = no auto-suggest, AS = with auto-suggest,  
 NDV = no domain vocabulary, DV = with domain vocabulary.

## 5.2 Number of Queries

The number of queries formulated in each task is shown in Table 4. As will be noted from the table, the number of queries was reduced to less than 2.0 by the auto-suggest interface, regardless of the inclusion of the domain vocabulary. A two-way ANOVA was conducted to determine if there was a significant difference in the average number of queries between the search interface type and the inclusion of the domain vocabulary. Significant main effects were found for the search interface type [ $F(1, 30) = 27.380, p < 0.001$ ] and the inclusion of the domain vocabulary [ $F(1, 30) = 7.797, p < 0.01$ ]. There was no significant interaction between the factors. In each case, the number of queries was smaller when either the auto-suggest interface or the domain vocabulary was adopted.

It is reported that the mean number of queries<sup>7</sup> in a user session is 1.73 (with a median of 1) for Web site search in a local government site [10]. This value is much lower than the mean value 4.86 (with a median of 8) observed in the case of a general-purpose search engine [9]. Since the type of search dealt in this study is not a general-purpose search but a Web site search, the number of queries improved by the auto-suggest seems to be a moderate level with regard to the case of the local government site. Needless to say, the number of queries alone would not be a good indicator of the search effectiveness. However, if we consider the high success rate as well as the reduced number of queries, it is reasonable to acknowledge the effect of the auto-suggest interface.

## 5.3 Precision and Recall

Table 4 shows precision and recall averaged across queries formulated by each participant within the two-minute search time. A two-way ANOVA was performed to examine differences in the precision and recall. ANOVA for recall revealed that there was a significant interaction [ $F(1, 30) = 19.486, p < 0.001$ ] between the search interface type and the inclusion of the domain vocabulary. As for the precision, significant main effects were found for the search interface type [ $F(1, 30) = 26.348, p < 0.001$ ] and the inclusion of the domain vocabulary [ $F(1, 30) = 10.942, p < 0.005$ ]. In each case, the precision was improved, and

<sup>7</sup> Not as unique queries but queries including repeat queries.

there was no significant interaction between the factors. In recent studies, the search performance is often assessed on the basis of the highly ranked items such as the top 10 results, and high recall is not always the standard assumption in the assessment of search results [11]. Therefore, regardless of no significant improvement in the recall, it is noteworthy that the precision has been significantly improved in this study.

In our auto-suggest interface, when a term is selected from the suggestions, a list of school documents are displayed as candidates (Figure 3). Currently, such candidates are listed in the order of document titles<sup>8</sup>, and sometimes it is not straightforward for the users to find out a desired item from a lot of candidates. A previous study investigated the ways of organizing items suggested by auto-completion in a known-item search task [19]. It was concluded that alphabetical order was suitable for a domain-independent lexical thesaurus, while domain-dependent grouping meaningful for users should be chosen carefully because every grouping strategy did not improve the search performance [19]. Further research will be needed for the organization of the suggested items, so that the quality of the search results can be elaborated.

## 6 Concluding Remark

In this paper we demonstrated the potential effectiveness of the auto-suggest interface, which exhibited better performance when used with domain vocabulary. The domain vocabulary utilized in this study was developed manually by school teachers and translation staff members. The effectiveness of the auto-suggest interface, therefore, may be dependent on the quality of the domain vocabulary. It is important to further investigate ways of developing vocabulary with semantic relations, so that the dynamic term suggestion technique can be applicable to the broader context other than the school education domain.

It would also be necessary to continue the evaluation with real users of multilingual school documents because the experiment presented in this paper was conducted with undergraduate students. In addition, currently the auto-suggest interface is integrated with the search box of the portal, but not fully integrated with the faceted search. We are planning to further investigate the effectiveness of the auto-suggest interface in cooperation with real users by using the full-featured faceted search system.

## References

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<sup>8</sup> In the order of Japanese phonetic characters, which corresponds to the alphabetical sequence in English.

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