S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

A Method for Detecting Focusing Utterance through Discussion in Collaborative Learning

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Abstract: In collaborative learning, learners discuss with other learners by exchanging their utterances. In order to represent effective utterances for knowledge acquisition timely, we propose a detection method of focusing utterances which are useful for understanding about their discussion. Focusing utterances are detected according to utterance types and understanding knowledge of learners. Focusing utterances are represented emphatically in the interface so as to distinguish them from normal utterances. Experimental result showed that our method could detect more than 60% of focusing utterances correctly.

Keywords: CSCL, awareness support, focusing utterance, round-table interface

Introduction

As the development of information and communication technologies, learners can easily meet and study with others through the network independently of time and location. To support these learners' activities in the shared virtual space, computer-supported collaborative learning (CSCL) is one of the interesting research fields in recent years [1]. Collaborative learning takes a learning style where learners try to solve their exercise through the discussion with others. However, learners cannot acquire much information about other learners' situations or behaviors because of the restricted communication band and it is still difficult to communicate with other learners through the network.
In order to attain communication among learners in distributed environments, one of the well-known concepts as awareness should be considered. Awareness provides the information: who is around, what activities are occurring, who is talking with whom and so on [2]. Many researchers engaged in CSCL fields have conducted on supporting awareness for learners [3, 4]. In collaborative learning, awareness for conversation is especially required since learners can acquire knowledge by exchanging their utterances. To support communication of learners, text-chat is commonly used in the CSCL system [5]. In text-chat, learners input their utterances carefully. In addition, learners are able to look back their utterances observing the chat logs in comparison with voice-chat. On the other hand, the synchronous collaborative learning using text-chat causes the difficulty to read all utterances and understand who is talking to whom about what. This problem has been known as chat confusion [6]. Therefore, to be aware of the conversation flow and the contents of utterances leads the footholds of their communication.
In this paper, we propose a detection method of the focusing utterances to enhance knowledge acquisition of learners. Focusing utterances which are useful for understanding knowledge are detected timely according to utterance types and understanding knowledge of learners. By observing useful utterances from the interface intuitively, learners can acquire new knowledge about their discussion more effectively.

1. Round-table Interface

In this research, we are focusing on the learners who discuss current topics and acquire new knowledge through the discussion. In order to support the real-time communication among

learners, we have proposed a collaborative learning support system in which focusing intentions for other learners and utterances can be reflected. Figure 1 shows the interface of our collaborative learning support system. Learners progress their learning by exchanging utterances through the text-chat. Round-table window corresponds to each learner's view and changes automatically according to the learners' action such as making utterance [7]. In addition, utterance texts are moved in the interface by inputting their utterance texts with utterance target information (particular learner or all learners) to represent the conversation flow. In order to be aware of the important utterances for leaners, focusing utterances which relate to each learner are estimated and represented in the interface with different manners from other utterances [8]. Figure 2 shows the examples of moving utterance among learners (b1, b2) and displaying focusing utterance (c).

Experimental result about the display method of utterances showed that participants intuitively grasped the flow of utterances by observing the moving utterance texts. However, the precision rate of detected focusing utterances was low, since the method only detects the utterances whose targets are learner himself/herself. The goal of this research is to modify the detection method of focusing utterances from the viewpoint of acquiring the new knowledge.

Figure 1: Interface of our collaborative learning support system

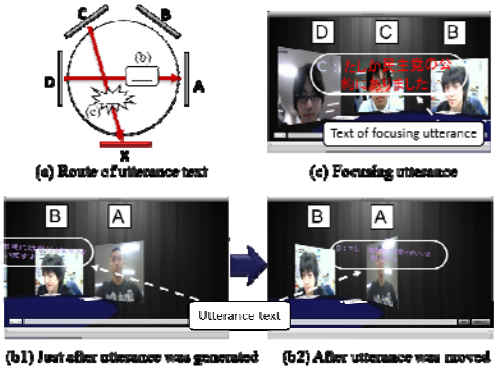

Figure 2: Example of moving utterance among learners and displaying focusing utterance

2. Focusing Utterance of Learners in Discussion

In order to analyze the feature of focusing utterances of learners, we investigated the chat log of the collaborative learning conducted in our laboratory. Two groups which were organized individually by four participants were asked to discuss topics about current Japanese society for 30 minutes. After the discussion, participants were asked to select utterances on which they focused during the experiment from the chat log.

We examined utterance types of selected utterances. Based on the category of the utterance type [9], all utterances were attached either type "Propose", "Explanation", "Agree", "Disagree", "Question", or "Others". In groups 1 and 2, 116 utterances (total 241 utterances) were selected as focusing utterances by participants and more than 80% of focusing utterances were "Explanation". This result indicates that learners focus on the utterances which are useful for understanding knowledge for their discussion. In addition, there was a tendency to select the utterance which includes new keywords at the time. It indicates that a learner may not know/understand the keywords that are not discussed so far. For detecting these focusing utterances timely, keywords and utterance types from each utterance should be extracted. When the utterer makes an "Explanation" utterance, he/she may understand the keywords in the utterance. On the other hand, the utterer may not know the keywords in the case of "Question" utterance. In this manner, understanding degrees for each keyword are different from individual learners according to the utterance types. In order to estimate the focusing utterance for each learner, we introduce the *understanding*

knowledge of learner which is represented as a set of keywords and these understanding degrees. Figure 3 shows the mechanisms for detecting focusing utterances. When an utterance is occurred, its keywords and utterance type are extracted. In addition, the understanding knowledge of the learner is estimated. Based on the utterance information and understanding knowledge of learners, the focusing degree of the utterance for learner is calculated. If the utterance is detected as a focusing utterance, it is represented differently from normal utterances in the round-table window.

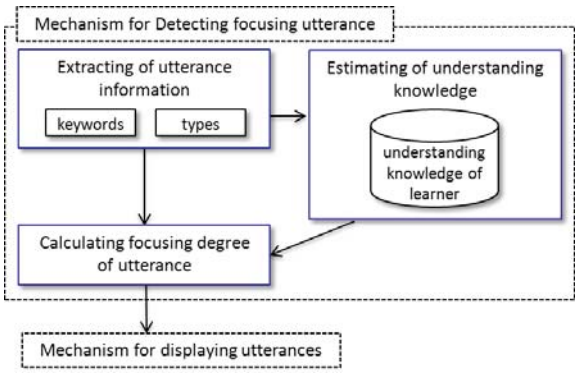

Figure 3: Mechanisms for detecting focusing utterances

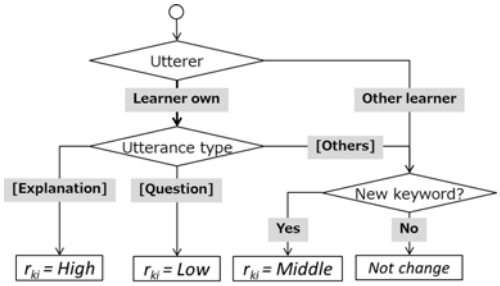

Figure 4: Flow chart of determining understanding degrees of keywords

3. Detection Method of Focusing Utterance

3.1 Extraction of Keywords and Utterance Types from Utterance Texts

Keywords in utterance texts are defined as a noun/unknown word or successive nouns/unknown words and extracted by using morphological analyzer [10] for Japanese language. Utterance types are estimated based on cue words in utterance texts. In order to extract the utterance whose type is "Explanation" or "Question", we analyzed the utterance texts of the past chat log and defined the Japanese cue words for these utterance types respectively. For example, "?" is a cue word for "Question". Currently, we define 33 cue words for "Explanation" and 1 cue word for "Question". If utterance text does not have cue word, it is assigned as "Others".

3.2 Estimation of Understanding Knowledge of Learner

Based on the extracted keywords and utterance types, the understanding knowledge of each learner is estimated as a set of keywords and these understanding degrees. The understanding knowledge of learner X is represented as R_X which includes a set of keyword k_i and their understanding degrees r_{ki}. The degree of r_{ki} takes either *Low*, *Middle* or *High* ($0 \leq Low, Middle, High \leq 1$).

When an utterance is occurred, the keyword k_i which appears for the first time is added in R_X. Then, understanding degrees of each keyword are determined based on the utterance type and the utterer information. Figure 4 shows the flow chart of determining understanding degrees of keywords. When learner X is an utterer and the utterance type is "Explanation", the understanding degree is set as *High*. On the other hand, the degree becomes *Low* if the type is "Question". In the case of "Others", the degree is set as *Middle* or *not changes* according to the existence of the keyword in R_X. If the utterer is the other learner, the understanding degrees change as the same way as "Others".

3.3 Calculation of Focusing Degree of Utterance

Focusing degrees of utterances for learner *X* are calculated when the utterer is the other learner and the utterance type is "Explanation". Following is the equation for calculating focusing degree of utterance *u*. K_u indicates keywords included in the appeared utterance *u*, and $K_{u,X}$ shows keywords of utterance *u* which are included in R_X . The degree becomes large if a number of new keywords are included in the utterance text. Based on the calculated focusing degree, the utterance which is larger than the threshold is judged as focusing utterance.

$$F_u = \frac{|K_u| - \sum_{\forall i \in K_{u,X}} r_{k_i}}{|K_u|} \quad (1)$$

Texts of focusing utterances are emphatically displayed in the round-table window. The color of a focusing utterance is highlighted and its font size becomes bigger. Moreover, its fading-out time is longer than that of the normal utterance.

4. Experiment

In order to evaluate the appropriateness of the detected focusing utterances, groups 1 and 2 organized by four participants were asked to discuss topics about current Japanese society, i.e. "screening of budget requests", for 30 minutes using the round-table window.
Before the experiments, participants practiced how to operate in the interface. Representations of the utterance texts of both focusing and normal utterances were explained. After the discussion, participants were asked to select utterances which were useful for understanding knowledge for their discussion from the chat log. The utterances selected by participants were compared with the focusing utterances detected by our method. In this experiment, we set understanding degrees *High, Middle and Low* as 1.0, 0.5 and 0 respectively, and the threshold which judges the focusing utterance as 0.5.
Through the experiments, 112 (in group 1) and 130 (in group 2) utterances were occurred. Table 1 represents the precision and recall rates of detected focusing utterances. From the results, our detection method could detect more than 60% of participants' focusing utterances correctly. Table 2 is a part of the utterances in Group 2, which is originally generated in Japanese. Although, utterances 32 and 33 included cue words of "Explanation", the method did not detect these utterances as the focusing utterance. These utterances only explain the feelings of utterers and do not provide new keywords, so no participants selected these utterances as focusing utterance. Therefore, in this case, our method could detect successfully participants' focusing utterances. On the other hand, utterance 115 selected as a focusing utterance by one participant was not detected by our method. Utterance 115 did not include keywords so that it was not detected as focusing utterances.
In group 2, there was a participant *A* who actively contributed to make utterances for other participants. 60 utterances were made by *A* while the number of all utterances is 130. Within the *A*'s utterances, there were 19 utterances whose types were "Explanation". After the experiments, some participants commented that *A* had led their discussion. The average of *A*'s recall and precision rates were lower (40.0% and 50.0%) than those of other participants (61.3% and 69.1%). This result indicates that our method could detect focusing utterances of the participants who tend to acquire the knowledge more correctly than those of participants who lead the learning.

Table 1. Precision and recall rates of detected focusing utterance

	Detected focusing utterance	Selected focusing utterance	Correct focusing utterance	Recall rate	Precision rate
Group 1	67	64	41	64.1%	61.2%
Group 2	63	72	42	58.3%	66.7%
Total	130	136	83	61.0%	63.8%

Table 2. Example of utterances (Translated into English)

No.	*Utterer*	*Type*	*Content of utterance*
30	C	Question	Do you mean that there are scenarios written by officials in [*1]MOF?
31	B	Question	Have government official in [*2]MEXT already known about it?
32	**A**	**Explanation**	**I'm not sure about that…**
33	**A**	**Explanation**	**If they knew, they would get angry about it.**
114	C	Question	Were about hundred requests screened?
115	**D**	**Explanation**	**I know not all the results of screening were not reflected in actual budget.**

[*1]MOF: Ministry of Finance
[*2]MEXT: Ministry of Education, Culture, Sports, Science and Technology

5. Conclusion

In this paper, we proposed a detection method of focusing utterances which are useful for understanding knowledge for their discussion. In the experiment, our method detected more than 60% of focusing utterances correctly. In addition, it reveals that our method could support the participants who tend to acquire the knowledge than the participants who lead the learning. To confirm the effectiveness of our detection method whether learners can acquire new knowledge through the discussion, further evaluations with more groups should be conducted.

Acknowledgement

This research was supported by Grand-in-Aid for Research Fellow of the Japan Society for the Promotion of Science (No. 21-1764).

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