Development of Group Division Algorithm And Discussion Support System for Intra-class Discussions

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Abstract

I studied the computer system that was characterized by the algorithm for dividing one class of students into several groups for group discussion. This paper describes the configuration of the proposed computer system, the algorithm of the group division, and the execution process of actual group discussions, assisted by this system, about specific topics.

Keywords*:* Group division, Discussion support system, Algorithm

1. Introduction

With the development of e-learning systems, computer-assisted collaborative learning and group learning have become more popular. I studied the computer system that was characterized by the algorithm for dividing one class of students into several groups for group discussion(Akahori, 1997). This computer system is used for the group division, however, it is not used in the later group discussions because the actual discussions are made as traditional face-to-face communication activities. This computer system can be also called the computer-assisted, group discussion support system. Concretely speaking, this system divides one class into multiple groups according to students' answers of a discussion topic by using a specific algorithm, and each student is notified of the names of the members who belong to the same group. The students then form groups according to the notified information, exchange opinions, and discuss the topic to increase understanding. As almost all students have their own cell-phones, the computer server collects information necessary from students and distributes information to students via cell-phones.

This paper describes the configuration of the above computer system, and the algorithm of the group division. This paper also describes the execution process of actual group discussions, assisted by this system, about specific topics.

There is a difference in the group division algorithm between this paper and the previous paper(kitagaki et.al., 2007). In the previous paper, we divided a student class based on the students' answers to the test. That is, values 1 and 0 were assigned to the right and wrong answers of the test respectively, and the class was divided into groups according to these assigned values. On the other hand, in this new paper, we divided a

student class into groups according to the information on debater's choices about the discussion topic instead of the above test answers. In the group dividing process, as the similarity of contents among these choices should be considered, we assigned values 0 and 1 to the choices, respectively.

2. Discussion Support System

Discussion support system is implementing the system flow shown in *Figure 1*.

(1)Registration of student's attributes: The mail address of students, name and other information such as sex, generation can be inputted to the computer… Among these, mail address is necessary and their names are used for students to know all the group member. These registrations are done on a Web page. The URL of the page is informed to all students in advance.

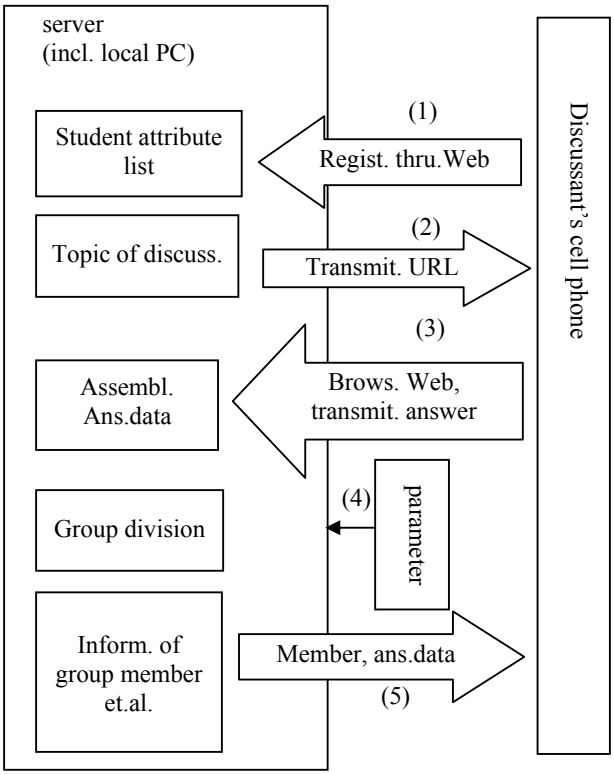

Figure 1. System configuration

(2)Sending URL of a topic and its choices: The teacher selects a subject among prepared topics. Then the computer sends the URL for browsing the topic to all discussants.

(3)Browzing the Web of a subject and sending the student's answer to the server: All students make an access to the URL mentioned above, then read the topic and the choices. They select a choice among the choices for the given topic then send it to the server. All the answer are gathered and stored in the server.

(4)group division: The computer server makes the group division according to the student's answer as transaction data. The basic idea of the group division is explained in the next section. In the actual administration, the following parameters and the necessary information ought to be inputted prior to the group division.

1. the value with which a topic is discussed.
2. the difference of choices in their contents.
3. the number of a group constituents

When the information of group division is obtained as a processed result, it is possible for a teacher to add, to it, remarks to each group, remarks to each individual and remarks to the all.

(5)sending the group division information to the students: The computer server sends to each student's mail address the group members, each answer and the remarks above if any.

Through the process above, each student is informed the name of all member which belong to the same group. Then, each group gathers somewhere inside or outside of the classroom and starts to deeply consider the topic by discussion.

3. Method of group division

Group division can be made by two kinds of criterion as the followings.

(a) *difference*: Groups are made so that choices of each member may be different from those of others as much as possible.

(b) *similarity*: Group are made so that choices of each member are similar with those of others as much as possible.

Two criteria are reverse in their evaluation of 'goodness'. Thus it is enough only to explain criterion (a). As for the criterion (a), two methods have been proposed (Kitagaki, 1996; Kitagaki *et. al.*, 1981). The proposed system in this material adopts the simpler method (Kitagaki *et. al.*, 1981). The argorithm is outlined below.

topic sets: M
topic: $m_i(\in M)$
value of the topic: $v(m_i)$
group sets: G
relevant group: $g(\in G)$
bigness of group 'g': $|g|$
discussant(student): $x_j(\in g)$
selected choice: $a(m_i,x_j)$
difference of choices selected by discussant x_j and discussant x_k: $d\{a(m_i,x_j),a(m_i,x_k)\}$

goodness of group division using criterion (a): α_g
goodness of group division using criterion (b): α'_g
goodness per capita of group division: β

In the definition above, both of 'value of the topic' and ''difference of choices selected by discussant x_j and discussant x_k' are the value between 0 and 1. The 'bigness of group 'g'' is the number of a group. The number is not always the same for all group. But its algorithm is abbreviated here. All the said variables have to be determined in advance. The 'goodness per capita of group division β' is determined as the following.

[1] $$\alpha_g = \sum_{m_i \in M} \sum_{x_j \in g} v(m_i) \bigcup_k d\{a(m_i, x_j), a(m_i, x_k)\}$$

[2] $$\beta = \sum_{g \in G} \alpha_g / \sum_{g \in G} |\, g \,|$$

In the equation [2], group division which makes the value maximum is the optimal solution. In order to get the optimum, however, it is necessary to administrate the calculation for all the combination of groups. It is actually difficult to get it because of time for its calculation. Thus a simple method is implemented (Kitagaki *et. al.*, 1980) as the following. Its example deals with the case that thirty discussants are divided into ten groups with three discussants each.

As the initial status, I suppose that the computer fix the discussants x_1, …, x_{30} as shown in 'n = 1' Figure 2, and define the value of β in eq.[2] as β_1. Then I let it compare cell1 with each cell thereafter one by one. First, let it exchange cell1 x_1 for cell2 x_2 to obtain the pattern as shown in 'n = 2' then get the value β as $\beta_{1,2}$. It is clear that $\beta_{1,2}$ is same as β_1 in their value. Thus there is no reason to exchange thus it ought to be withdrawn. Second, it is obvious that the exchange of x_1 and x_3 leads to the same result as above. It is cell1 and cell4 that has actual meaning of exchange because they belong to different groups in the initial pattern. If β_1 is bigger than(or equal to) $\beta_{1,4}$, the computer regards the pattern of 'n = 4' as not better pattern than the one of 'n = 1' then the exchange ought to be withdrawn. On the other hand, if β_1 is smaller than $\beta_{1,4}$, it regards the pattern of 'n = 4' better than the one of 'n = 1' then the exchange ought to be done to get the new pattern. Based upon the new pattern, it searches for a better pattern. The search for the better pattern is succeeded in the same way.

Consequently, the exchange of two cells are done in the following order, and as a result, the number of exchange becomes 870 (= 29*30) in all. (Actually the exchange of two cells in a group ought to be omitted.)

cell1 and cell2, cell1 and cell3, cell1 and cell4,cell1 and cell5, …,cell1 and cell29, cell1 and cell30
cell2 and cell3, cell2 and cell4, cell2and cell5, …,cell2 and cell29, cell2 and cell30
cell3 and cell4, cell3 and cell5, …,cell3 and cell29, cell3 and cell30

……
cell29 and cell30

Supposing the number of discussant to be 'n', the number of the said exchange becomes 'n (n – 1)'. For each exchange, the computer gets the value of β, then the optimal group division is obtained.

n=1

cell1	cell2	cell3	cell4	cell5	cell6	…	cell28	cell29	cell30
g_1			g_2			…	g_{10}		
x_1	x_2	x_3	x_4	x_5	x_6	…	x_{28}	x_{29}	x_{30}

n=2

cell1	cell2	cell3	cell4	cell5	cell6	…	cell28	cell29	cell30
g_1			g_2			…	g_{10}		
x_2	x_1	x_3	x_4	x_5	x_6	…	x_{28}	x_{29}	x_{30}

n=4

cell1	cell2	cell3	cell4	cell5	cell6	…	cell28	cell29	cell30
g_1			g_2			…	g_{10}		
x_4	x_2	x_3	x_1	x_5	x_6	…	x_{28}	x_{29}	x_{30}

Figure 2. The exchange of two cells(in the case that a classroom consists of thirty students)

If method (b) shown in the beginning of this section is implemented for group division criterion, we have only to use eq.[3] instead of eq.[1].

[3] $$\alpha'_g = \sum_{m_i \in M} \sum_{x_j \in g} v(m_i) \bigcup_k \{1 - d\{a(m_i, x_j), a(m_i, x_k)\}\}$$

4. The administration of discussion classroom

As a topic for the proposed discussion, I raised a topic of career development to which most students might be relevant. The topic relates the consideration on the answer in an interview in job hunting. I administrated the classroom discussion four times. In every administration, the same topic was used. Two experimental administrations are discussed below.

[experimental 1(E1)] Fifteen Hiroshima University students served as subject (twelve undergraduate students and three graduate students). Among them, nine students were science in major., Jul. 26, 2007.

[experimental 2(E2)] Fourteen Hiroshima University students served as subject (seven undergraduate students and seven graduate students). Among them, nine students were science in major., Nov. 11, 2007.

In both of E1 and E2, I used the same room and implemented the same topic which consists of two rounds, R1 and R2, that is, two 'Question-Answer' set. But the students were different in those two experiments. In either round, the question exemplified in Table 1 was used. In its actual administration, I let the students inform others in a group of the choice which each student has selected then discuss what would be a better answer for the given answer. Lastly I let them make and write a better answer then offer it as a report with of their consensus.

Table 1

A questionnaire and the answer
(Nakatani, 1995)

Q: What worker do y ou want to be? A: As human is not working alone, I want to be a worker regarding communication with others in the actual work where I should say whatever necessary to say and listen to them whenever to do that . # As your remark for the underlined parts, select a choice that is nearest to it. 1. The expression is vague and fuzzy thus have little impact. 2. No fresh awareness as a new comer. can be felt. 3. Everybody can say that thus little impact are there. 4. It is the president of a company to say that. Thus, if the matter gets worse, it may give them a feeling of impoliteness.

As most students in a group were not acquainted with each other, it was assumed that, when the information of a group member were presented in the step of Figure 1(5), it gets difficult for them to make a group. Thus ID number proper to each group was informed all the classroom, leading to easier making groups. Addition to that, as group leaders is necessary in order to facilitate the discussion well, how to determine a leader in a group was also informed them. Discussion time was set to nearly fifteen minutes, which was also informed them as a comment.

After each administration of R1 and R2, the following questionnaires have been examined to all the students.

(Influence of selecting a choice on the discussion flow)

1. I don't think that the information of a choice selection had an influence on the relevant discussion flow. In other words, discussion flow must have been the same as the one without selecting a choice.

2. I think that the information of a choice selection had an influence on the relevant discussion flow to some extent.

3. I think that the information of a choice selection had an influence on the relevant discussion flow to great extent.

In R1 and R2, presented topics were the same type thus those answers were added to have been statistically processed altogether. The result is shown in Table 2(a). There is also shown the result in the case that E1 and E2 were combined in their data.

From the test result shown in the table, the average choice for the questionnaire is said to be 2 (or in-between 2 and 3). It means that their average remark is that selecting a choice has an influence on the discussion flow as their awareness.

Besides the experiment shown in this material, I have done the questionnaire survey comparing criterion (a) with criterion (b) shown in the 3rd section supposing the case that groups were divided according the criterion (b). As their awareness, it got obvious that they felt more fruitful in their discussion with variety of choices in a group than that with a similar choices.

Table 2

Answer data processing of ' influence of selecting a choice'
(a)basic statistics

condition	number of students selecting a choice □□□			X	σ
	□	□	□		
□E1□R1&R2□	0.30	0.57	0.13	1.90	0.65
□E2□R1&R2□	0.07	0.46	0.46	2.39	0.61
□E1&E2,R1&R2□	0.19	0.52	0.29	2.10	0.69

Number of the students is fifteen 15 in E1, and fourteen in E2.
X : average, σ : standard deviation

(b) Z-test(using normalized distribution)

condition	m		
	1	2	3
(E1, R1&R2)	-7.42^{*}	0.86	9.13^{*}
(E2, R1&R2)	-11.9^{*}	-3.37^{*}	5.20^{*}
(E1&E2, R1&R2)	-12.2^{*}	−1.15	9.94^{*}

* Hypothesis 'X=m' has been rejected($p<0.01$), $Z = \dfrac{(X - m)\sqrt{N}}{\sigma}$

5. Conclusion

In this research, I have developed an algorithm for group division where discussion on a subject is done in a group. For that objective, I made a system configuration. As a result

of its administration, it got clear that the discussants have an awareness that letting them know their selected choice each other gave an influence on the further discussion flow.

REFERENCES

AKAHORI, K. *et. al.* (1997, in Japanese), *The skill of university classroom teaching*, Daiichi-houki, Tokyo, 142-145.

KITAGAKI, I., HIKITA, A.,TAKEYA, M., FUJIHARA, Y. (2007), Development of an algorithm for groupware modeling for a collaborative learning, *Int'l Journal of Computers, Communication & Control*, II, 1, 66-73.

KITAGAKI, I. (1996), Evaluation of students' group using fuzzy integral, *IEICE*, J79-D-II, 11, 1888-1896.

KITAGAKI, I., SHIMIZU, Y. and SUETAKE, K. (1980), An instructional method which permits the studentsto critically discuss their own test answers, *Japan Journal of Educational Technology*, 5, 1, 23-33.

NAKATANI, A. (1995, in Japanese), *Expert of interviewing*, Diamond Co., Tokyo.