

Extracting Student Motivation Factors in Education with Contextual Inquiry

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Abstract—In education, there are many students in a class. Each student has its own characteristics in motivation. However, in a class, a single uniform curriculum is applied to all the students. It is difficult to teach every student according to their characteristics. It is necessary to understand student motivation. It needs a great labor to understand the every student motivation. In this paper, we propose a method to understand the student motivation factors. In this method, we get reports from students based on the contextual inquiry. The method extracts words from the report. Using the TF/IDF method, it calculates the weight of every word from the viewpoint of 4 major motivations. The method registers the set of a word and weight values into a dictionary. The method calculates the motivation factors of the target student, summing up the weight of words appearing in the report. High interest for every motivation factor is examined from 74 student reports. Even though there is accuracy difference with the length of the report, the method has classified the reports almost in the same way as manual judgment. The proposed method can reduce the efforts of teachers who have to understand motivation of various students.

Index Terms—education, MSLQ, contextual inquiry, TF/IDF, motivation

I. INTRODUCTION

In education, students have various characteristics, such as a request, volition, and capability. Each student has his own motivation for learning. Motivation factors vary with individual students. However, all students are taught along one curriculum regardless of student motivation factors in many lectures. As a result, students are prevented from their improvement of ability because all students are not motivated. In order not to decrease the student motivation, we should reflect needs and opinions of students to teaching contents. We need to devise a teaching method according to them. In order to include needs and opinions of students to the curriculum, conventional methods often use questionnaires. However, in questionnaires, any information other than answers to prepared questions cannot be obtained because all

questions are prepared in advance. For problems out of education assumption, we cannot judge student needs and opinions of students exactly. As other methods, educations make students describe their problems in reports written in free texts. However, in this method, teachers should read all student reports, to understand student motivation factors. It makes the load of teachers high. It is necessary to devise a method which extracts student motivation factors without increasing the load of teachers.

In this paper, we propose a method which extracts student motivation factors based on the contextual inquiry [1]. The contextual inquiry is superior to questionnaires and free-text descriptions, because it loses no context. The proposed method analyzes scenarios obtained from the contextual inquiry, to calculate student interests for each motivation factor. We can improve the curriculum using student motivation factor extracted with this method.

II. DIFFERENCE OF MOTIVATION FACTORS IN EDUCATION

A. Importance of Teaching According to Motivation Factors

Currently, many researches on motivation have been done [2]-[4]. Therefore, it is believed that motivation is assumed to be an important factor in education.

It needs to understand motivation factors of each student in order to devise an efficient teaching method which draws student motivation. Current teaching method cannot encourage all students. It needs to devise a teaching method which can encourage many students in one curriculum. The realization of the method needs to examine realize student characteristics, that is, we have to know when students are motivated.

B. Motivation Factors

MSLQ [5] defines motivation factors specifying which student gets motivated. Here, four typical motivation factors are put into consideration. The intrinsic goal orientation factor is a motivation factor which comes from the inside of a student. It involves is ambition and

curiosity. Students with motivation factor would try to achieve as much as possible. On the other hand, the extrinsic goal orientation factor is an external motivation factor. For example, students want to get good grade and want to win fame from other students. The task value is a motivation factor where learning tasks become the source of motivation. For example, students think learning is important for his future works, or students are interested in tasks in a target field of learning. MSLQ also mentions that students should acquire self-management skills. The help seeking skills is one of them. The help seeking skill makes students ask for help to other people when they encounter difficulties. Owing to this skill, students can overcome the difficulties.

C. Contextual Inquiry

It needs to fully understand opinions and requests against lecture students have to understand student motivation factors. There is questionnaire and free description as a way to obtain information from students. But, in questionnaire, any information other than answers to prepared questions other than cannot be obtained because of the fixed question. In free description free opinions can be obtained, but the opinions are rough. In these methods, necessary information can be obtained.

The contextual inquiry obtains free opinions in detail. The contextual inquiry is a way to understand potential problems and needs of users from their behavior and system usage through interviews.

In interviews, a user explains his usual actions. If there is anything an interviewer does not understand, the interviewer asks the user why the user take such action. Thereby, the interviewer can understand a way of thinking inherent in the user. If we can obtain the opinions and requests of students using the contextual inquiry, we can understand the student motivation factor by the analysis of opinions and requests.

In education, there are two important points when obtaining information from students. First, it needs to obtain many student data. Teachers need to analyze the results of all student interviews. Therefore, the loads of teachers increase. Second, it needs to obtain valid information to improve lectures. It needs to reduce information teachers analyze. In addition, it is important to devise a teaching method according to motivation factors.

III. EXTRACTING MOTIVATION FACTOR FROM ANALYSIS OF REPORTS

A. Overview of the Method

This paper shows a method to determine student motivation factors and to extract students who have high interest in a specific motivation factor from analysis of reports. This method helps a teacher know which students have high interest in a specific motivation factor. It reduces the load of the teacher. Fig. 1 shows the outline of the method. First, students interview each other according to the contextual inquiry. Interviewers submit results as reports. The method looks up words students

use in the reports with the morphological analysis. It calculated the TF/IDF [6] importance of every word for each of motivation factors. Every combination of a word and its importance is registered into a dictionary.

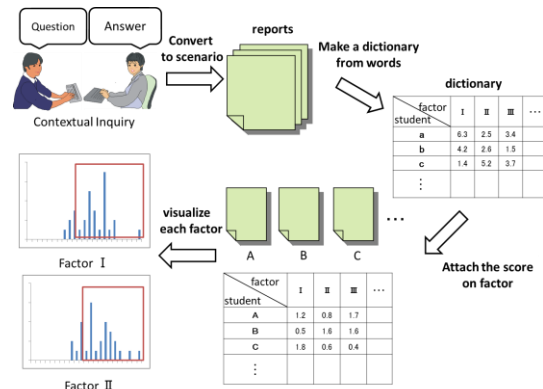


Figure 1 Outline of the method

To analyze new student reports, we prepare a dictionary from past reports. When we get a new report, we extract every word enrolled in the dictionary. At the same time, we sum up the importance of the word for every motivation factor. For a specific motivation factor, we make a histogram whose vertical axis and horizontal axis represent the number of students and the accumulated importance for the specific motivation factor. We regard students located in the low level in the histogram do not have interests in the motivation factor, while students in the high level have enough interests. We can understand student motivation factor with the analysis.

B. Collecting of Reports

To obtain potential problems and needs from user behavior and system usage, the method lets students interview with each other, after lectures on the basis of the contextual inquiry. Each interviewer submits the report which is the result of the interview. We can obtain many student data after we have the students interview each other. It is hard for students to get programming ability.

Many students do not understand significance of programming. Therefore, student who mentions discontent and grumbling increases if this interview is carried out during the programming course. Emotion of discontent and grumbling prevents requirements for programming from appearing in interviews. Therefore, student motivation factor is not extracted well. On the other hand, students who have passed lot of time since they finished the programming lecture may have forgotten requirements. We decide the target of interviews to students who have just finished the programming lecture to carry out the interview rational.

C. Weight of Word by TF/IDF

Students have some motivation factors. It is considered that student who has strong interests in a specific motivation factor frequently use words which concern the motivation factor. In this study, many reports which students show interests in a specific motivation factor are

gathered. Words are extracted from these reports. Every motivation factor is associated with words using the weight. If students have interest in only a specific motivation factor and other students have no interest in the motivation factor, the student frequently use words which relate to the motivation factor. In addition, the words are not used other student reports. Therefore, we use TF/IDF to determine the word weight. The value of TF/IDF is calculated with product of the word frequency of occurrence and the degree the word appears only in the specific document. If total number of words is N and the word w occurs n times in the document, the frequency of the word occurrence tf is represented by the formula 1.

$$tf = n / N \tag{1}$$

Suppose the total number of reports which are obtained is R and the word w occur in reports. When the degree idf to which the emergence word w in a specific report is calculated by the formula 2.

$$idf = \log_2(R/r) \tag{2}$$

If word w occurs in some report, idf becomes large. For word w , the value of TF/IDF is represented by the formula 3.

$$f = tf \times idf \tag{3}$$

Therefore f becomes small when word w occurs in a report and report where w rarely occurs. The value of TF/IDF each word has is defined as the weight against the motivation factor.

Let the weight of the word for a motivation factor be f_t^i . We can obtain n pairs of motivation factor.

$$(w_t, f_t^1, f_t^2, \dots, f_t^n)$$

This pair represents weight of all motivation factors against each word. This pair is made for each word. A set of the pair is referred to as a dictionary which is used in this method. If the weight of word for a motivation factor is large, students who use this word have large interest in the motivation factor.

D. Extracting Interest in Motivation Factor

If we can judge a student who has strong interest in a specific motivation factor, a teacher can focus on reports the student write when the teacher devises his teaching method related to the motivation factor. In this section, we explain a way to extract students who have strong interest in each motivation factor. Fig. 2 shows the flow to extract the degree of the interest on each motivation factor. For each word appearing in a student reports, the weight registered in the dictionary is summed up for each motivation factor. The report of various lengths may come out. Long report has many words, which increases the total value. Finally, the total value is divided by the number of words which is used in a report when we

calculate the total value, so that we should evaluate the fair degree of an interest regardless of the report length. Namely, the degree of an interest is the average weight of the emerging word registered to the dictionary. If the total number of words in the report is n , the degree of an interest to a motivation factor is calculated with the following formula $\sum f_t^i / n$. The degree of an interest in each motivation factor is scored by the above procedure. Next, we make histogram for each motivation factor to extract upper students on histogram. It is conceivable that these students frequently use words which relate to the motivation factor in the report. Therefore, we can judge the student have interest to the motivation factor.

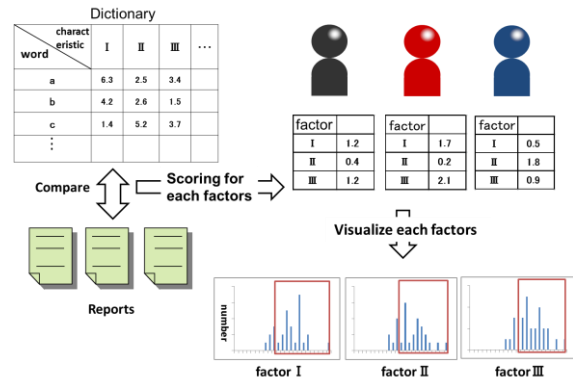


Figure 2 Extracting motivation factor

The performance of the system is affected by a way to extract upper student. Generally, many students have interest to some motivation factors. It is not good that a teacher devises his teaching method only to refer to the report. Therefore, it needs to exclude students who have a low degree of the interest. In addition, if there are students who have strong interests only in a specific motivation factor, the average is large. For this reason, we should be avoided to determine a threshold with the average. Considering the above, in this study, we decide the threshold as the quartile point of the fourteen. The students of top 75 percent are regarded as ones having strong interests in the motivation factor, while those of the bottom 25 percent are regarded as ones having no interests.

IV. EXAMPLE OF EXTRAQCTING DEGREE OF INTEREST TO MOTIVATION FACTOR

A. Obtain Reports by Interview

We examine to extract student motivation factors on the programming exercise by this method. An experiment has been conducted for 74 students. The students are taught to contextual inquiry in advance. The average number of words in the report in this experiment in 574 words, the variance of the number of words in the report is 163,472. The variety of length of reports in conceived from this dispersion value. In the experiment, students who have finished the programming exercise are imposed a report to state, when they get motivated in programming. We oblige the students to make a pair, to

interview with each other. Each student submits a result of the interview as a report.

B. Making a Dictionary by Analyzing Reports

Student reports are divided at a ratio of 7:3. The former is used for analysis, while the latter is used for creating a dictionary. Student reports factor for creating a dictionary are analyzed based on MSLQ to extract interests in motivation factors. The reports are grouped according to each motivation factor. In this experiment, if student report includes a description related to a motivation factor which defined in MSLQ, it is judged that the student has the motivation factor. Thereby, four groups are made. A reports can belong some groups. Next, in each group, we extract words from reports. The value of TF/IDF is calculated for each extracted word. The value of TF/IDF is regarded as the weight of the word in the each motivation factor. Pairs of a word and its weight constitute a dictionary. In this experiment, 1881 words are extracted to a dictionary.

C. Extracting Student Motivation Factor by Using Dictionary

Using the dictionary, we have calculated the degree of student interest in each motivation factor. On the other hand, readers judge the student motivation factor contents of reports manually.

We have compared the result of determining to quantify the degree of student interest from the weight of a word for the motivation factor with the result of judging presence or absence of interest to motivation factor by readers of the report.

The degree of the interest to the four motivation factors are calculated from the analysis of reports using the dictionary. In analysis, words are extracted from student reports. The weight of each motivation factor of words which are registered in dictionary is summed up. Next, the sum is divided by the number of times. The calculated value is regarded as the degree of the interest to each motivation factor.

We collect the degree of the interest to a student motivation factor and make a histogram. We compare the result of extracting top of 75 percent students on histogram with the result of classified students obtained the reading of student reports. We examine how much percentage of students who are classified by the reader is included in the top of 75 percent on the histogram.

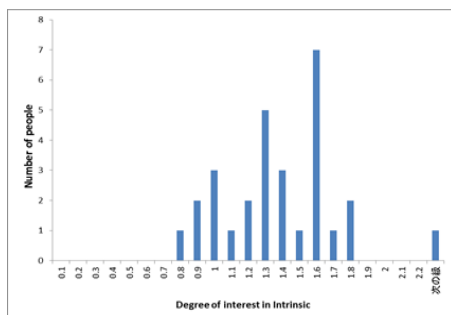


Figure 3 Degree of interest in intrinsic

V. EVALUATIONS

A. Experiment Result

We evaluate four motivation factors. The intrinsic goal orientation one, the extrinsic goal orientation one, the task value one, the help seeking one, which are defined in MSLQ. Fig. 3 shows a histogram which obtained in experiment for the intrinsic goal orientation one.

The horizontal axis is the degree of the interest to the motivation factor and the vertical axis is the number of people. Histogram shows the distribution of the degree of the student interest to each motivation factor. Students judged as they have strong interest to the intrinsic goal orientation motivation factor by readers of the report are eight. Seven of them locate in the top of 75 percent students on the histogram. The histogram shows that most of students are located in the range from 1.4 to 1.6. They have strong interest in the extrinsic goal orientation one by readers of the report are seven. Five of them locate in the top of 75 percent students on histogram. For this motivation factor, most of students are located in the range from 1.6 to 1.7 in the histogram. On the other hand, students who do not locate in the top of 75 percent students are located from 0.9 to 1.0 in the histogram. Students judged as they have strong interest in the task value one by readers of the report are seven. Five of them locate in the top of 75 percent students on the histogram. Two of these nine students have strong interest. But, other seven students distribute near the threshold which is determined in this method. Students judged as they have strong interest in the help seeking one by readers of the report are twelve. Eleven students of these twelve students are judged as they have strong interest in this method. We investigate whether students judged as they have strong interest in each motivation factor by readers of the reports contain top of 75 percent students. We quantify the percentage of students classified by readers is included in the top of 75 percent on the histogram. Table I shows the result. We obtained recall of more than 70 percent for motivation factor other than the task value. It is possible to extract students who have strong interest to motivation factor for the intrinsic goal orientation, the extrinsic goal orientation, and help seeking motivation factor. Therefore, it is possible to reduce student reports which a teacher should read by selecting reports of students who have strong interest in each motivation factor. As a result, we can reduce load of teacher.

TABLE I. RECALL OF EACH MOTIVATION FACTOR

	intrinsic	extrinsic	task value	help seeking
Recall	87.50%	71.43%	55.56%	91.70%

B. Discussion

We can extract students who have strong interest in each motivation factor in this method. But, we cannot judge whether the interest in positive or negative. Therefore teacher should read student reports and judge positive and negative of degree of interest. However, we understand that this method limits the reports which the teacher should read when he judges positive and negative

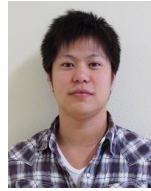
of student interest to motivation factor. From this it is possible to support that teacher chooses reports which include valid information to improve lecture. If student report is short or long extremely, the judgment by readers of reports does not match the result of this method.

In this method, the degree of the interest in a motivation factor is calculated as the average of the weight per occurrence of the word. Extremely long reports have many words which do not relate to the motivation factor. The average is low because of using these words. Students who write long report is judged so as not to have interest to motivation factor which he have interest essentially. This problem is solved by eliminating word which do not relate to motivation factor. Extremely short reports do not have a meaningful description. It is impossible to calculate the degree of the interest to a motivation factor.

As another problem, we could not extract exactly student motivation factor if a student use words different from ones used in reports to make a dictionary. This problem is solved if we make the dictionary from many reports.

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