The research on evaluation of the WBT teaching materials for mathematics

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ABSTRACT

Recently, the chance that e-learning is used is increasing. The preliminaries are being prepared in the school education, and the practical use as accessory of teaching materials is expected. On the other hand the declination of basic scholarship of university students has been a problem. Scholastic attainments that the student is demanded at the university are requested from such a situation from the strategy acquired promptly and efficiently. In this research, the teaching material evaluation technique for finding the problem of itself by using data mining for the study history data was examined. It was tried to derive two or more students' learning patterns from the study history data by using the data mining by rough set and the GA, and to use it for the teaching material evaluation such as finding the problem included in.

Keywords: e-learning, WBT, data mining, rough sets, genetic algorism (GA)

1. Introduction

Recently, the practical use of e-learning as teaching materials is increasing by growth of network technology and the popularization of computer. E-learning is the technology in which various study contents can be learned always freely. The system offered on the Web among e-learning is especially called WBT (Web-Based Training). It begins to spread focusing on education in a company, and is used also for correspondence course such as linguistic acquisition and qualification acquisition. Furthermore, the graduate school which can learn all subjects only by e-learning is established. The preliminaries which use e-learning by government initiative are being prepared, and the practical use as accessory of teaching materials is expected also in the school education. From such demand, it is required the research and development of e-learning system and to make teaching materials which is easy to use and can study efficiently.

On the other hand the declination of basic scholarship of university students has been a problem in recent years. Therefore, at the university they repeatedly teach the contents of high school level, such as calculus, for example in mathematics. However, selection of the contents is difficult and there is much futility also for a student because of the degree of acquisition of student is various when the lesson form which the same contents is used all at once in all the members. From such a situation, it is required a student is put on quickly and efficiently conditions in the academic ability demanded at a university.

In this paper, based on these backgrounds, calculus was taken up out of high school mathematics, and examined the development of the WBT system which aimed at enabling it to master basic scholarship efficiently for a short period of time and the teaching materials evaluation technique by data mining. Data mining is attracts attention in recent years as the technique of extracting the useful knowledge out of a vast quantity of data stored on the computer. A merit of a WBT system is not only can learn various teaching materials freely anywhere, but the learning history of a student being acquirable in detail. By analyzing the detailed perusal enrollment of teaching material's page obtained from the

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access log of a system, it becomes possible to pursue learned behavior until it results and to manage a student. The learning histories obtained by the trace of learned behavior become the material information for grasping the relationship between a learning process and the degree of acquisition. If a student's training pattern can be derived by performing data mining to the learning histories, it will be possible that the derivation of useful information to teach, and the proposition for raising the degree of acquisition efficiently. Furthermore, attained by deriving two or more students' training pattern for every teaching material, it can be expected discovery of the issue included in the teaching materials and evaluation of teaching materials. In order to prepare the environment which the diffusion of an e-learning system is raised and many students can learn efficiently, it is required acquisition of the information which be able to guide every student carefully, and structure which can discover where it exists whether the issue as teaching materials exists. However, since study historical data acquirable from a system become huge so that the number of users of a system increases, there is a boundary in the analysis in man power. Moreover, in order to correspond to the demand of the e-learning contents forecasted to increase in large numbers, it is needed the work of changing so that the conventional teaching materials can be used as e-learning teaching materials. But an error mixes by work mistake, or the error is contained from the first, or possibility of being the formal teaching materials unsuitable for providing as e-learning teaching materials primarily is also considered. If discovery of such issue has the huge amount of teaching materials, it is not realistic. Then, the construction of technique that can discover an issue automatically is required. In this paper, construction of the WBT system that can meet such a demand and its evaluation technique was offered.

The teaching material and the system that can study efficiently are necessary to make it study efficiently. Therefore, the teaching material evaluation technique for finding the problem of itself by using data mining for the study history data was examined in this research. It was tried to derive two or more student's learning patterns by using data mining for the study action data, and to use it for the teaching material evaluation such as finding the problem included in the teaching material. Moreover, it is thought that deriving information that enables methods and techniques of instruction from the obtained pattern to the student to be done in detail becomes possible, too. In this research, it aimed at the construction of the WBT system that was able to study efficiently by deriving such information in a short term, and the teaching material evaluation technique from the study history data was examined.

2. The knowledge acquisition method using Rough sets and GA together

There is a technique called data mining to what attracts attention in recent years as the technique of extracting the useful knowledge which cannot be heard about which and known only by glancing out of a vast quantity of data stored on computer[1,2]. The concept of the rough set advocated by the computer scholar Zdzislaw Pawlak of Poland in 1982 is one of those which attract attention as one of the promising knowledge acquisition technology[3]. It is possible to derive the brief determination rule group which has determination capability equivalent to a specialist by using the concept of a rough set. Useful knowledge is extracted out of a vast quantity of data, and research utilized for various fields is done by this.

By the technique using a rough set, the problem for which computation time is exponentially needed with the increase in data

Table 1 The information collected from access log

Category	No.	Item	Value
Student's status	1	Belonging faculty	Informatics, Law, Literature
	2	Mathematics subject finished in high school	1, 2, 3, A, B, C
	3	Sex	M/F
Learning environment	4	Inspection time	time
	5	Study place	IP address
	6	Elapsed time from login	time (second)
Lesson inspection pattern	7	Average per 1 page of Lesson in unit inspection time	time (second)
	8	Repetition inspection frequency on the same Lesson page in unit	Frequency
	9	Repetition inspection complete rate on Lesson page in unit	0% - 100%
Problem answer pattern	10	Average per 1 question of Question in unit answer time	time (second)
	11	Interval from Lesson inspection in unit to Question answer	time (second)
	12	Frequency of studying the same unit	Frequency
Result	13	Correct answer rate of Question in unit	0% - 100%

size was left behind. Then, in order to solve the problem of computation time, the knowledge acquisition technique which used together genetic algorithm (Genetic Algorithms: GA) and a rough set was proposed [4]. In this research, the knowledge acquisition is used by this technique.

3. The knowledge acquisition method in access log analysis

3.1 The Working test of WBT System
The examinee chiefly recruited applicant from the students, who study mathematics, of Department of Literature and Department of Law and Faculty of Informatics. This system did not set the limitation in making the system use account to recruit the examinee widely to obtain data as a lot as possible, and made everyone available. Therefore, there is also a user from outside the university and a total of 147 examinees were obtained.

Grasping a student's perusal history correctly, it is necessary to peruse and operate teaching materials only in a single window. In this research, the usage of a system is explained to an examinee in advance, and action was correctly recorded on the access log. Since it was aimed only at the data of the examinee who has explained the usage, only the data of student 96 was set as the object of analysis among all examinees.

Data mining is the technique of deriving a useful rule out of a huge quantity of data. Therefore, if there are few amounts of data of the object which performs data mining, it will be thought that a useful rule is hard to be drawn. Then, the data of a student with little perusal number of pages among the obtained access logs was excepted, and only the data of a student with the perusal number of pages more than fixed numbers was set as the object of data mining.

3.2 Creation of determination table

1) Creation of the case group
Since Lesson and Question were prepared for every unit, the access log for one unit of one person was made into one case, and the case group was created so that the relation of those perusal situations and results could be derived. Information collectable from one access log is shown in Table 1. By making into a determination table the case group constituted from these items, the determination rule group which shows a learning pattern is derived.

The example of a generable case group is shown in Table 2. 439 cases were acquired in this research. Table 2 extracts 10 pieces from this 439 case as an example.

2) Classification
Since the continuation value is included in the case group in Table 2, data mining by rough set cannot be performed. Therefore, classification is done as shown in Table 3. The item which is a discrete value from the first, such as the affiliation faculty, sex, a study place, etc., divided into the individual class. However, about the affiliation faculty, into the examinee, since there were few students of Department of Law department and a Department of Literature, it was considered as the same class. When the whole access log was seen, when continuation values, such as lapsed time and perusal time, were short time, there were many cases, and since it had become exponential distribution that there were few cases when it was long time, they were exponentially divided like "10sec, 20sec, 40sec, 80sec". About access time, since four time when the number of accesses becomes a peak existed, as such 11:00, 15:00, 21:00, 1:00, made one class even time which had decreased since the time which the number of accesses begins to increase, and divided as morning, afternoon, night, and midnight. In addition, no access into the log from 3:00 a.m. by 6:00 by this research, either, this range was made into the 5th class and 24 hours was divided into five classes. It was made for the number to distribute equally in every class by this.

The result which evaluated by performing classification to each value of the case group of Table 2 is shown in Table 4. Data mining is performed using the condition attribute sequence and determination attribute sequence of this table as a determination table.

4. The knowledge acquisition about action of study

4.1 Creation of determination table
The decision table shown in Table 4 is cut out to each student, and the decision table according to the student is made. Performing data mining to them, it is possible to derive a student individual's learning pattern. It can be expected that the difficult fine educational guidance becomes possible in a past teaching material, because the teacher understands a peculiar study style to the student from the pattern and it guides the student. Moreover, in order to take out better results with comparing with the rule which is taking out good results, it can also expect it to become possible to examine how learned behavior should be improved.

When it starts for every student, the condition attributes which do not make a meaning exists in the determination table shown in Table 4. For example, status peculiar to a student, such as the contents of completion of an affiliation faculty or high school mathematics and sex, is different attributes for every student, and if it observes only one student, it will serve as the always same

Table 2 Created case group (select 10 cases of 439 cases)

No.	Student ID	Section no	1	2	3	4	5	6	7	8	9	10	11	12	13
case 1	1	A1-02-01	Informatics	123ABC	M	22	out	7517	10	3	100	16	Immediate	0	100
case 2	32	A1-02-01	Informatics	123ABC	F	21	out	140	22	0	100	11	Immediate	0	100
case 3	31	A1-02-01	Informatics	123ABC	M	20	out	622	13	4	100	8	Immediate	0	100
case 4	30	A1-02-01	Informatics	123ABC	M	11	in	3046	6	0	100	9	Immediate	0	100
case 5	29	A1-02-01	Law	12AB	M	1	out	3167	3	3	100	8	Immediate	0	100
case 6	28	A1-02-01	Informatics	123ABC	M	18	out	268	4	0	100	11	Immediate	0	100
case 7	27	A1-02-01	Informatics	123ABC	M	18	out	988	21	0	100	7	Immediate	0	100
case 8	27	A1-02-01	Informatics	123ABC	M	22	out	962	2	0	25	3	Immediate	0	100
case 9	2	A1-02-01	Informatics	123ABC	F	13	in	8955	5	4	100	9	Immediate	0	75
case 10	3	A1-02-01	Law	12AB	F	12	in	5325	14	2	100	16	42	0	75

Table 3 Classification

Category	No.	Attribute name	Value				
			1	2	3	4	5
Student's status	1	Belonging faculty	Informatics	Law			
	2	Mathematics subject finished in high school	1, 2, 3	1, 2, 3	1, 2	1, 2	
	3	Sex	male: M	female: F			
Learning environment	4	Inspection time	morning	afternoon	night	midnight	early morning
	5	Study place	in	out			
	6	Elapsed time from login	15min	30min	1h	2h	more
Lesson inspection pattern	7	Average per 1 page of Lesson in unit inspection time	5sec	15sec	30sec	1min	
	8	Repetition inspection frequency on the same Lesson page in unit	none	1	2	3	more
	9	Repetition inspection complete rate on Lesson page in unit	100%	less 100%			
Problem answer pattern	10	Average per 1 question of Question in unit answer time	10sec	20sec	40sec	80sec	more
	11	Interval from Lesson inspection in unit to Question answer	Immediate	other			
	12	Frequency of studying the same unit	first time	1	2	3	more
Result	13	Correct answer rate of Question in unit	100%	less 100%	less 75%	less 50%	less 25%

Table 4 Created determination table

condition attribute												Decision attribute
1	2	3	4	5	6	7	8	9	10	11	12	
1	1	1	3	2	5	2	4	1	2	1	1	1
1	1	2	3	2	1	3	1	1	2	1	1	1
1	1	1	3	2	1	2	5	1	1	1	1	1
1	1	1	1	1	3	2	1	1	1	1	1	1
2	4	1	4	2	3	1	4	1	1	1	1	1
1	1	1	3	2	1	1	1	1	2	1	1	1
1	1	1	3	2	2	3	1	1	1	1	1	1
1	1	1	3	2	2	1	2	1	1	1	1	1
1	1	2	2	1	5	1	5	1	1	1	1	2
2	4	2	1	1	4	2	3	1	2	2	1	2

Table 5 Condition attributes for each student determination table

attribute		condition attribute name
condition attribute	1	Inspection time
	2	Study place
	3	Elapsed time from login
	4	Average per 1 page of Lesson in unit inspection time
	5	Repetition inspection frequency on the same Lesson page in unit
	6	Repetition inspection complete rate on Lesson page in unit
	7	Average per 1 question of Question in unit answer time
	8	Interval from Lesson inspection in unit to Question answer
	9	Frequency of studying the same unit
Decision attribute		Correct answer rate of Question in unit

value. Therefore, when cutting out for every student and creating a determination table, these condition attributes are unnecessary. Then, first of all, an unnecessary condition attribute is deleted from based determination table, and the determination table of only the attribute shown in Table 5 is created. Next, a determination table is cut out and divided each student, and as the case included in one determination table turns into only one student's case, it creates two or more determination tables. The study rule for every student is derived by performing data mining to those determination tables.

4.2 Results
Table 6 is the decision algorithm which is derived from the log of a Faculty of Informatics student who is studied all the mathematics of high school mathematics 1, mathematics 2, mathematics 3, Mathematics A, the mathematics B, and mathematics C. Rule.3 are the rule that a percentage of correct answers is 100%, when the reply time of Question is short. It is thought that it was the teaching materials of the contents which can already be understood well for this student that reply time is short and can answer correctly. However, like Rule.10, although the perusal time of Lesson is long, the rule that a percentage of correct answers is 0% is also drawn. Since the reply time of Question is also taken for a long time, with these teaching materials, it is thought that the lower level teaching materials which are not offered are required.
Fig. 1 is the frequency of appearance for every condition attribute

Table 6 The determination algorism

	1	2	3	4	5	6	7	8	9	Result
Rule.1	3			3						1
Rule.2	3		3				3			1
Rule.3							1			1
Rule.4			4	5	1					1
Rule.5				4						1
Rule.6				2						1
Rule.7			2							1
Rule.8			1	5						5
Rule.9				5						5
Rule.10				4			4			4
Rule.11			4				3			3
Rule.12						2				3
Rule.13				2	1		2			2
Rule.14			3	3						2

of Table 6. In all decision algorithms, it turns out that most condition attributes 3 and 4 are used. The condition attribute 3 is the lapsed time from login, and the condition attribute 4 is the average perusal time of Lesson. Therefore, this student can say that the conditions most related to results are the lapsed time from login, and the average perusal time of Lesson. On the contrary, about none used condition attributes, such as study place and the perusal interval of Lesson and Question, the number of times of re-practice, it turns out that results are not influenced.

5. The knowledge acquisition about teaching materials evaluation of the macro range

5.1 Creation of determination table
The determination table shown Table 4 cut out for every chapter and the determination table according to chapter are created. By deriving the determination rule which performed data mining to them and made results the determination attribute, it is thought possible to derive in which chapter the problem is included. It is expectable that the tendency about the rough problem part of teaching materials is grasped, and it can utilize for correction of teaching materials or future teaching materials work by this. In a specific unit, some condition attributes which cannot explain correlation with results exist in the determination table shown in Table 4. For example, even if the result "a percentage of correct
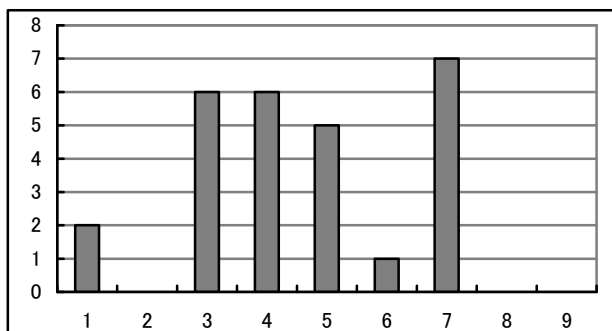

Fig .1 Frequency of condition attributes

Table 7 Condition attributes for each student determination table

attribute		condition attribute name
condition attribute	1	Belonging faculty
	2	Mathematics subject finished in high school
	3	Average per 1 page of Lesson in unit inspection time
	4	Repetition inspection frequency on the same Lesson page in unit
	5	Repetition inspection complete rate on Lesson page in unit
	6	Average per 1 question of Question in unit answer time
	7	Interval from Lesson inspection in unit to Question answer
Decision attribute		Correct answer rate of Question in unit

answers are high to a morning" comes out by the relation between perusal time and results, it is impossible to evaluate teaching materials from the rule. Similarly, it is the condition attribute which cannot explain a relation with results easily about sex, a study place, and the lapsed time from login, and the perusal interval of Lesson and Question. Then, these condition attributes are excepted as a condition attribute used for teaching materials evaluation, and create the determination table of only the attribute shown in Table 7. Next, based determination table is cut out and divided for every chapter, and as the case included in one determination table turns into only a case of one chapter, it creates two or more determination tables. By performing data mining to these determination tables, the study rule for every chapter is drawn and teaching materials evaluation of each chapter is performed.

5.2 Results
Table 8 is a decision algorithm about Chapter 1 Section 2 of these teaching materials. It analyzed by dividing into plurality because that many units were contained in Chapter 1. Table 8 is one of them.
A poor-achieving rule is observed. In Rule.1, although Lesson perusal time is long and is perusing repeatedly, the percentage of correct answers has been a rule of 0%. Moreover, in Rule.21, although Lesson perusal time is long and Question reply time is also long, the percentage of correct answers has been a rule of 25% or less. A possibility that a problem is in the composition and the chapter from these can be considered. However, like Rule.11, if Lesson perusal time is long and there is several numbers of times of duplication perusal, the rule from which a percentage of correct answers become 100% is also drawn. It turns out that the students who can understand Lesson by reading well from this and the student who cannot understand although read well are. That is, it is thought that the necessity of adding the description about a little easier level to the contents of teaching materials according to the student rather than there is a problem is shown. Chapter 1 is a part which is giving the description about a limit. A limit is a difficult subject to understand in mathematics, and to make it understand as no good explanation. Therefore, from this result, it can be said that it need to be improved such as insertion of the page which explained the meaning of "lim" in detail, add the link which can refer to other related description pages easily and so on.
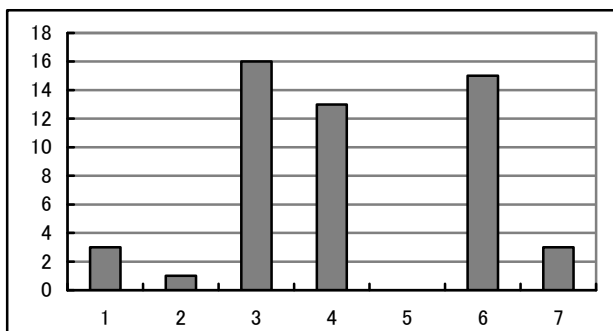

Fig .2 Frequency of condition attributes

Table 8 The determination algorism of section 1-2

	1	2	3	4	5	6	7	Result
Rule.1			5	5				5
Rule.2			2			2		5
Rule.3	2					3		5
Rule.4			2	5				5
Rule.5			2			5		1
Rule.6			3			4		1
Rule.7				4		4		1
Rule.8			3	2				1
Rule.9				1		5		1
Rule.10						2		1
Rule.11			5	2				1
Rule.12			2	5				1
Rule.13				1			2	1
Rule.14			5	1		4		3
Rule.15			2	1				3
Rule.16				1		3	1	3
Rule.17						2		3
Rule.18			2	2		3		3
Rule.19			1			5		2
Rule.20			1			4		2
Rule.21			4			5		4
Rule.22				4		3		4
Rule.23	2					5		4
Rule.24	2		2					4
Rule.25		4		5				4

In addition, 6.4% of questions in this WBT teaching materials were a question about the Lesson page in the object of Table 8. In that page, there ware post mistakes of expression and making mistakes of navigation. Although perusal time is long, the cause which is not high-achieving is considered that these mistakes may have influenced.

Fig. 2 is the frequency of appearance for every condition attribute of Table 8. In all decision algorithms, it turns out that most condition attributes 3 are used. The condition attribute 3 is "the average perusal time of the Lesson page in a unit". Moreover, the condition attribute 6 is the next used, and it is "the average reply time per Question in a unit". Therefore, in this chapter, the conditions most related to results are the average perusal time of Lesson, and it can be said that the average reply time of Question has also influenced. On the contrary, the condition attribute 5 is no used and it is "the rate of perusal completeness of the Lesson page prepared in the unit". It turns out that whether all the Lesson pages were read has not influenced results.

6. The knowledge acquisition about teaching materials evaluation of the micro range

The teaching materials have been evaluated in the rough with the teaching materials of the macro range together. Furthermore, in order to clarify the position of teaching materials including a problem and to pinpoint a part to be corrected concretely, the analysis for the micro range is required. Then, the determination table for all the teaching materials pages in each unit is created, and the determination rule group is derived such that can pinpoint the part of the teaching materials which have a problem from there. It can expect to utilize for evaluation and an improvement of teaching materials by specifying the part that should be corrected using the derived rule.

Table 9 The information collected from access log

No.	Attribute name	Value
1	Mathematics subject finished in high school	1, 2, 3, A, B, C
2 - 6	Inspection time of 1 page of Lesson in unit	time (second)
7	Repetition inspection complete rate on Lesson page in unit	0% - 100%
8 - 13	Answer time of 1 question of Question in unit	Time (second)
14	Frequency of studying the same unit	Frequency
15	Correct answer rate of Question in unit	0% - 100%

Table 10 Created case group (select 10 cases)

No.	Student ID	Section no	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
case 1	1	A1-04-01	123ABC	32	8	0	0	0	40	64	6					1	3
case 2	32	A1-04-01	123ABC	30	42	14	13	7	100	13	37					1	1
case 3	31	A1-04-01	123ABC	29	9	4	6	4	100	16	3					1	1
case 4	30	A1-04-01	123ABC	19	6	3	8	13	100	15	30					1	3
case 5	29	A1-04-01	12AB	13	0	0	0	0	20	23	428					1	1
case 16	1	A1-02-02	123ABC	55	17	31			100	6	15	9	14	33		1	3
case 17	32	A1-02-02	123ABC	16	36	108			100	16	11	11	12	16		1	1
case 18	30	A1-02-02	123ABC	2	2	2			100	5	6	6	6	9		1	2
case 19	29	A1-02-02	123ABC	6	6	1			100	9	10	12	14	12		1	1
case 20	28	A1-02-02	12AB	5	2	4			100	13	6	6	10	19		1	1

Table 11 Classification

No.	Attribute name	Value						
		1	2	3	4	5	6	7
1	Mathematics subject finished in high school	123ABC	123AB	12ABC	12AB			
2-6	Inspection time	None	5sec	10sec	20sec	40sec	80sec	more
7	Complete rate	100%	less 100%					
8-13	Answer time	10sec	20sec	40sec	80sec	more		
14	Frequency of studying the same unit	first time	1	2	1			
15	Correct answer rate of Question in unit	100%	less 100%	less 75%	less 50%	less 25%		

Table 12 Condition attributes for the determination table

attribute		condition attribute name
condition attribute	1	Belonging faculty
	2	Inspection time of Lesson 1
	3	Inspection time of Lesson 2
	4	Repetition inspection complete rate on Lesson page in unit
	5	Answer time of Question 1
	6	Answer time of Question 2
	7	Answer time of Question 3
	8	Answer time of Question 4
	9	Frequency of studying the same unit
Decision attribute		Correct answer rate of Question in unit

Table 13 The determination algorism of section 1-2-1

	1	2	3	4	5	6	7	8	9	Result
Rule.1			7							5
Rule.2							2			5
Rule.3	1	5								1
Rule.4			6							1
Rule.5			5			5				1
Rule.6						4				3
Rule.7			4				5			2
Rule.8			2							2
Rule.9			3			1				2
Rule.10		6	3							4
Rule.11			4			1				4
Rule.12	4	3								4

6.1 Creation of case group

The case group of Table 2 every Lesson and Question pages has no individual data, it newly extracts information from a log file, and creates the case group for every unit newly.

Although the point to assume the access log for one unit of one student to be one case is the same ahead, the information collected for this case group is shown in Table 9. The example of a generable case group is shown in Table 10. This extracts 10 in all cases. It is because that a blank exists in a table is the Lesson number or Question number which does not exist in the unit of the case.

6.2 Classification

The continuation value is included in the case group of Table 10 as well as the case group created in Table 2. Classification is performed as shown in Table 11 because of data mining by rough set cannot be performed using these values as it is. The result which evaluated by performing a classification to each value of the case group of Table 10 is shown in Table 11. Data mining is performed using the condition attribute sequence and determination attribute sequence of this table as a determination table.

6.3 Creation of determination table

One unit is extracted from the case group of Table 10, and the determination table for performing data mining in the micro range is created. In the determination table in the micro range, the number of condition attributes differs for every (every unit) determination table. Table 12 is the attribute used for the determination table of teaching materials "section 1-2-1: average rate of change and differential quotient.". In a section 1-2-1, 2 pages of Lesson pages and 4 pages of Question pages exist. As shown in Table 12, the determination table for unit 1-2-1 has two condition attributes of Lesson perusal time and four condition attributes about Question reply time. It is Table 13 which drew the decision algorithm from the determination table created as a result.
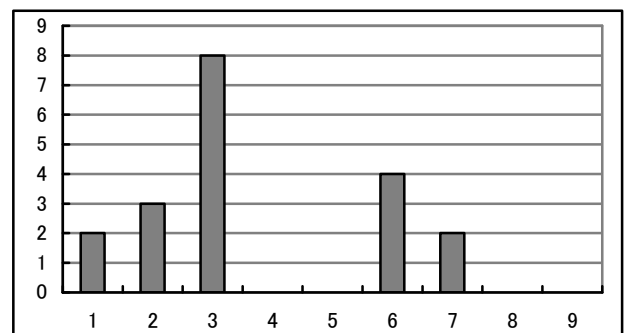

Fig .1 Frequency of condition attributes

6.4 Result

The poor achieving rule is observed. Although Rule.1 has the very long perusal time of Lesson2, the percentage of correct answers shows the rule which is 0%. Therefore, it is thought that a certain problem may be included in Lesson2. As for all the teaching materials prepared by this research, description is continuing from Chapter 1. By advancing study in an order from the beginning, the low student of degree of comprehension is making so that he can understand differentiation. Therefore, it is also possible to say that it is the point with which this stumbles by the result. This unit is a part treating a limit, and when the foundation is not understood from a current unit, it is thought that it is difficult to understand the contents. Therefore, since the result stuck in this part has come out, it is necessary to prepare the teaching materials promoted greater understanding from this as the previous teaching materials.

Fig. 3 is the frequency of appearance for every condition attribute of Table 13. In all decision algorithms, it turns out that most condition attributes 3 are used. The condition attribute 3 is the perusal time of Lesson2. Therefore, by this unit, it is thought that the perusal time of Lesson2 is important as conditions which determine results.

7. Conclusions

Finally by this research, the information which enables fine instruction to a student and the information which evaluates the teaching materials itself were derived from the study history information on WBT teaching materials by data mining. Development of the WBT teaching materials which can be efficiently learned by examining future WBT teaching materials based on that information for a short period of time was aimed at. The following knowledge was acquired by construction of this system.

1) Extraction of student's learning pattern
It became possible to pursue learned behavior to the results, as well as results management of a student, by detailed teaching materials page perusal record obtained from the access log of this system. The study history data obtained by the pursuit becomes the important information to know the relation between a learning process and the degree of acquisition. The learning pattern for every student has been derived by applying the data mining technique using a rough set and GA to the study history data. By using this derived knowledge for the educational guidance to a student, even if it is the WBT system which treats many students at once, it can be expected that fine education, the proposal about the future contents of study.

2) Teaching material evaluation of macro range
By summarizing the plural study history of the student for every teaching materials, and the data mining technique using a rough set and GA was applied. A student's learning pattern to the teaching materials was obtained, and practical use became possible as information for evaluation of WBT teaching materials. Whether there being any teaching materials with which it should supplement, discovery of the teaching materials with which a certain problem may be included, etc. were attained from these information.

3) Teaching material evaluation of micro range
The plural study history of the student is collected into the determination table which made the condition attribute by each of the page which constitutes teaching materials or exercises. It became possible to discover whether a possibility that the problem is concretely included in what teaching materials page is high, by applying the data mining technique using a rough set and GA to those data.

Moreover, the following evaluation results were obtained about the WBT teaching materials made by this research.

1) Deriving of difficult part
As a result of analyzing for every teaching materials based on the study history of a student, it became clear that the student is stuck in the part which is giving description of a limit or a tangent. About these, although preparation was giving the description from the foundation, it turned out that it was inadequate. Also in mathematical instruction, description of these parts has a high hurdle and it is a difficult problem how it should teach. When this part has derived as a problem, it turned out that it is necessary to add the description which can perform an understanding of these parts, and became the knowledge which is useful to a future teaching materials improvement. Moreover, it can be said that this was able to derive the part which has a problem in teaching materials using the valuation method in this research.

2) Improvement of teaching material interface
With the teaching materials made by this research, when moving to the following Lesson from a certain Lesson, the form linked to the following Lesson by the character string the "next" was taken. As a result of investigating an access log, it turned out that many students were perusing all Lesson pages. However, a student cannot know in advance what kind of description exists in the following page, and cannot determine whether learn the following page. Therefore, in order for a student to be able to choose the teaching materials perused of their will, it is necessary to improve that it may move to Lesson teaching materials from the table of contents which showed not a link like "next" but what kind of description of the form are included.

About the system built by this research, in order to make it the WBT system which is the policy objective of this research, and which can master basic scholarship efficiently for a short period of time, it is necessary to tackle the following subjects.

1) Improvement of accuracy
Since the results obtained by the method of the classification when creating the determination table are differ greatly, the method of a classification is examined and needed to be obtained a more high precision result. Moreover, in this research, although Lesson and Question which constitute a unit were made the set and the learning pattern was drawn, since Lesson and Question are not necessarily perused by a set, they need to consider the creation way of a determination table of having taken combination other than this.

2) Reexamination of method of acquiring access log
In this system, when a student opens two or more windows of a browser and peruses teaching materials using two or more windows simultaneously, there is a problem which cannot pursue learned behavior correctly. The recorded contents on an access log are the contents of the request sent to the server from the client, and it is because whether how many windows the student is open or the request from which window it being and information are not included there. In this research, it is excepted from the candidate for analysis about the student considered to have perused using two or more windows clearly. However, it is thought that it is common in case the operation method using two or more windows peruses the contents on a web, restricting this will force it a burden to a student, and it may cause decline in study efficiency. Therefore, even if it opens two or more windows and is perused, it is necessary to examine the structure which can pursue learned behavior correctly.

It tackles about the above subject and aims at building the WBT system which can master basic scholarship efficiently for a short period of time.

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