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Mining Educational Data to Analyze the Student Motivation Behavior

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***Abstract*—**The purpose of this research aims to discover the knowledge for analysis student motivation behavior on e-Learning based on Data Mining Techniques, in case of the Information Technology for Communication and Learning Course at Suan Sunandha Rajabhat University. The data mining techniques was applied in this research including association rules, classification techniques. The results showed that using data mining technique can indicate the important variables that influence the student motivation behavior on e-Learning.

***Keywords*—**association rule mining, classification techniques, e-Learning, Moodle log Motivation Behavior

I. Introduction

WITH the rapidly growth of the Internet, the web-based educational system has been increasingly used as an important tool to support learners and teachers. There are many benefits for information sharing and collaboration between learners and teachers in a course. Learners can take a web-based class to enhance their knowledge at any time and any place and teachers can easily create their online classes and monitor student's performance as well. Moodle is a popular Learning Management System (LMS) that supports educators to create the effective online courses. However, it did not provide the function to access and estimate learner's motivation behavior. Also Student's logs in a Moodle can show students' interactions like reading, writing, taking exam, and doing various tasks [1]. With a huge of accumulated information daily from e-Learning course, it is very difficult to analyze this data manually. Although there are some tools that help to report useful information which in turn is very valuable for analyzing student's pattern behavior [2], they do not offer specific features teacher need to track and evaluate all the students' activities in class [3].

Data Mining Techniques is the promising methodology to extract valuable information in this objective. Data Mining can analyze relevant information results and produce different perspectives to understand more about the students' activities so as to customize the course for student learning. For this paper, we used the data set of the Information Technology for Communication and Learning Course at Suan Sunandha Rajabhat University.

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The data is composed of demographic information of each student, information in this class and grade student obtained. After data preparation process, data mining techniques are applied to discover the valuable knowledge for analysis student motivation behavior. And the rest of this paper is organized as follows. Section 2 reviews about the related literatures and the related methodologies used in this work. Section 3 presents the implementation based on the purposed data mining techniques. In section 4 the result and discussion is presented. Finally, we conclude the paper with future research issues in section 5.

II. Relates works and the methodologies

In this section, we illustrate the literature search and the specified methodologies used in this project.

A. Relates Works

A literature search shows that most of the related researches have deployed data mining techniques to analyze student's learning behaviors by following this: According to C. Romero at el [4], the research was shown the usefulness of the data mining techniques in course management system and the rules can help to classify students and to detect the sources of any incongruous values received from student activities. K. Waiyamai applied data mining approach to develop new curricula and to assist engineering students for choosing an appropriate major [5] and B.Minaei-Bidgoli et al [6] presented an approach to classify students in order to predict their final grade based on features extracted from logged data in an education web-based system Data mining techniques like association rule mining were applied in [7],[8] to extract the patterns and to evaluate the activities of on line course and classification and association rule mining algorithms are discussed and demonstrated in [9]. Also there are many researches that have been investigated in the on-line learning environment. For example, West et al investigated impact of learning style on e-learning by using Statistics [10] and Kerdprasop et al used Rule induction rough set to Classify student knowledge level [11].

B. The Methodologies

Data Mining is the data analyzing approach from different perspectives to summarize the useful information results. The data mining process uses many principles as machine learning, statistics and visualization techniques to discover and present knowledge in an easily comprehensible form. There is another definition as "the nontrivial process of identifying valid, novel, potentially useful, and ultimately understandable patterns in data" [12], [13].

Association rule mining is used to discover interesting relationships between variables in databases. According to Agrawal et al [14], an association rule explains a close correlation between items in a database in the form of $x \Rightarrow y$ where x and y are sets of Item set I $(x \text{ and } y \subset I)$ and $x \cap y = \phi$. I= $I_1, I_2, \ldots, I_m$ is a Item set of m distinct attributes. The rule is indicated x implies y whereby x is called antecedent and y is called consequent. There are two importance thresholds for measurement association rule mining, minimum support and minimum confidence. The support of a rule $x \Rightarrow y$ is the probability of the Item set {x, y} that means the relevance of the rule and the confidence of a rule $x \Rightarrow y$ is the conditional probability of y given x that indicate the accuracy of the rule.

$$\text{Confidence}\ (x \Rightarrow y) = \frac{\text{support}(\{x, y\})}{\text{support}(x)} \tag{1}$$

and

$$\text{Support}\ (x \Rightarrow y) = \frac{\text{support}(\{x, y\})}{\text{Total number of transaction in D}} \tag{2}$$

Set of transactions: D = $\{d_1, d_2, \ldots, d_n\}$ each $d_i \subseteq I$

Confidence is a significant measure of the association rules to indicate how to strength of the mined rules. If the confidence of the association rule $x \Rightarrow y$ is 80%, it means that 80% of the transactions that contain x also contain y, based on users to indicate the specified minimum confidence [15].

Apriori Algorithm is an influential algorithm for association rule mining, purposed by proposed by Agrawal [16]. The Apriori Algorithm is used level-wise search for frequent item sets, the sets of items that have minimum support.

A decision tree is one of the most well known classification algorithms that are commonly used to examine data and induce the tree in order to make predictions [17]. The purpose of the decision tree is to classify the data into distinct groups or branches that generate the strongest separation in the values of the dependent variable [18]. Mitra S and Acharya T [19] classified the important decision tree methods from the machine learning community: IDS, C4.5, CART; and large databases: SLIQ, SPRINT, SONAR, RainForest.

The ID3 algorithm, introduced in 1986 by Quinlan Ross [20], uses the top-down induction of decision trees. ID3 uses information gain to build the leaves of the tree. A greedy search is used and the best attribute is selected by it and never reconsiders earlier choices by looking back [21].

J48 is an open source Java implementation of the C4.5 algorithm under WEKA data mining platform. C4.5 is an algorithm used to generate a decision tree developed by Ross Quinlan. C4.5 is a software extension and thus improvement of the basic ID3 algorithm designed by Quinlan [22]. J48 uses gain ratio to classify the decision tree.

III. Experimental Setup

The data set used in this research is collected the student's data from the Information Technology for Communication and Learning Course at Suan Sunandha Rajabhat University, in the period of 2010-2011.

As shown in Fig.1, the student data set was 3,140 records and it is composed of personal records, course (face-to-face) records and students' log file from e-Learning system.

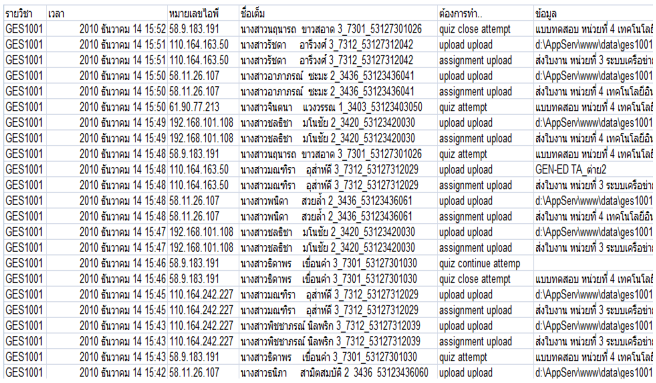

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Fig. 1 Raw data

Moodle has been used for this course. Moodle is an well known open source software for learning management system that offers teacher create and manage online classes effectively. From this Course, in the class (face-to –face) room, student must be required to attend in course room, to do exercises and project, and to take exams in class. Also, in e-Learning class, student needs to take pre and post quizzes online, to review and use materials on e-Learning system and to participate in exercises

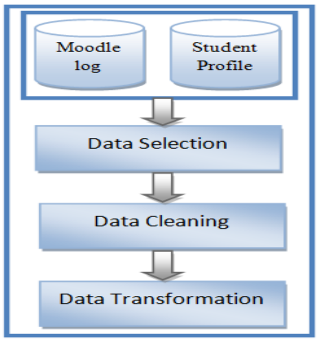

Fig. 2 the data preparation process

Also, the results of students' grade are collected in the last. From Fig.2, the data is preprocessed, and transformed to be appropriated format in order to apply data mining techniques to discover valuable information. We removed irrelevant attributes and reduced data sets contained with missing value. And all continuous attributes have been transformed to nominal attributes. There are various methodologies to transform numerical attributes to discrete attributes like equal width, equal frequency, clustering principles and etc. In this research, the equal width method was used to partition the value of continuous attributes into five nominal values: VERY LOW, LOW, MEDIUM, HIGH and VERY HIGH.

The table I shows the significant information of this research after preparation data. Data was analyzed by WEKA. WEKA, the Waikato Environment for Knowledge Analysis, is a collection of machine learning algorithm to analyze data set for data mining tasks [23].

TABLE I
IMPORTANT ATTRIBUTES

Name	**Description**
PreTest_number	Identification number of pretest
PostTest_number	Identification number of posttest
Result-PreTest_number	Mark obtained from pretest
Result-PostTest_number	Mark obtained from posttest
Time-of-PreTest_number	Time spent on pretest
Time-of-PostTest_number	Time spent on posttest
SumofPreTest	Total mark obtained from all pretest
SumofPostTest	Total mark obtained from all posttest
Time-of-viewing –material	Total time spent on viewing material
Time-of-upload –material	Total time spent on upload material
number-of-Attendance	Number of Attendance in class
Assignment_Number	Identification number of assignment
Result_ Assignment_Number	Mark obtained from assignment
InClassTest_number	Identification number of in class test
Result_ InClassTest_number	Mark obtained from in class test
Project_score	Mark obtained from project
Midterm-score	Mark obtained from Midterm
Final-score	Mark obtained from Final
Grade	Final mark obtain from this class

IV. RESULTS OF EXPERIMENTAL

A. Appriori Algorithm

Apriori algorithm has been used for this research and evaluated with a minimum support of 0.2 and a minimum confidence of 0.9 to presents significant relationships between the activities of students on this class and their final scores. Fig 3 shows examples from the results of Apriori algorithm.

```
Best rules found:

 1. Midium=Very Low 409 ==> Count-Test-P=Very Low 397    conf:(0.98)
 2. Count-P-test=Height 469 ==> Count-Test-P=Very Low 448    conf:(0.98)
 3. Count-P-test=Height Midium=Low 341 ==> Count-Test-P=Very Low 324    c
 4. Count-P-test=Very Height Count-Test-P=Very Low Grade=High 347 ==> Cou
 5. Count-P-test=Very Height Grade=B+ 406 ==> Count-assign=Very Height 38
 6. Count-Test-P=Very Low Grade=B+ 374 ==> Count-assign=Very Height 353
 7. Grade=High 433 ==> Count-assign=Very Height 408    conf:(0.97)
 8. Count-assign=Very Height Grade=High 408 ==> Count-P-test=Very Height
 9. Grade=High 433 ==> Count-P-test=Very Height 406    conf:(0.97)
10. Final=Medium Grade=High 341 ==> Count-assign=Very Height 319    conf:
11. Count-assign=Height 441 ==> Count-Test-P=Very Low 412    conf:(0.97)
12. Count-assign=Very Height Count-Test-P=Very Low Grade=High 353 ==> Cou
13. Count-assign=Very Height In-Class=Very Height Project=Very Height 371
14. Final=Medium Grade=High 341 ==> Count-P-test=Very Height 317    conf:
```

Fig. 3 Results of Apriori algorithm

From the results of Appriori approach, there are many unnecessary rules teachers are not interested in. Therefore, for this research, the selected rules are explained in the Fig.4, based on decision of teacher.

Discovered rules	Conf.
Count-P-test=Very High Final=Medium Count-assign=Very High ==> Grade= Very High	0.98
Final=Medium Count-assign=Very High ==> Grade= Very High	0.98
Count-assign=Very High In-Class=Very High Count-P-test=Very High ==> Grade= Very High	0.98
Count-P-test=High Project=High Count-Test-P=Very Low ==> Grade= Very High	0.98
Count-assign=Very High Final=Medium Count-P-test=Very High ==> Grade= Very High	0.98
In-Class=Very High Count-P-test=Very High ==> Grade= Very High	0.97
Count-P-test=Very High In-Class=Very High Count-assign=Very High ==> Grade= Very High	0.97
Count-P-test=Very High Count-assign=Very High ==> Grade= Very High	0.97
In-Class=Very High Count-assign=Very High ==> Grade= Very High	0.97
Count-Test-P=Very Low Medium=Low Count-assign=Very High ==> Grade= High	0.97
Count-P-test=Very High Medium=Low Count-assign=Very High ==> Grade= High	0.97
Mid=Low Count-assign=Very High ==> Grade= High	0.96
Mid=Very Low Count-Test-P=Very Low ==> Grade= High	0.96
Final=Medium Count-assign=Very High Count-P-test=Very High ==> Grade= Very High	0.96
Count-P-test=Very High In-Class=Very High Count-assign=Very High ==> Grade= High	0.95

Fig. 4 Results of selected rules

"Grade", is significantly attributed to student motivation behavior. Accordingly, it was being discretized in to five levels: VERY LOW, LOW, MEDIUM, HIGH and VERY HIGH. Based on the derived testing result, 30% of the data set used for training, the result is depicted in Figure 5.

Student Motivation Behavior Levels	Testing set	Accuracy	
		Number of Record	Percentage
Very High	224	187	83.5
High	284	254	89.44
Medium	164	125	76.22
Low	112	87	77.68
Very Low	117	78	66.67
Total	901	731	81.13

Fig. 5 Results of testing mined rules

B. Decision Tree Algorithms

ID3 and J48 are utilized in this research and Fig 6(a) and (b) present the results of these algorithms.

```
Id3

Count-assign = Very Height
|  In-Class = Very Height
|  |  Midium = Low
|  |  |  Count-P-test = Very Height
|  |  |  |  Final = Low
|  |  |  |  |  Count-Test-P = Very Low: High
|  |  |  |  |  Count-Test-P = Very Height: High
|  |  |  |  |  Count-Test-P = Height: High
|  |  |  |  |  Count-Test-P = Medium: Medium
|  |  |  |  |  Count-Test-P = Low: High
|  |  |  |  Final = Very Low: null
|  |  |  |  Final = Medium
|  |  |  |  |  Count-Test-P = Very Low
|  |  |  |  |  |  Project = Very Height: Very High
|  |  |  |  |  |  Project = Height: High
|  |  |  |  |  |  Project = Very Low: null
|  |  |  |  |  |  Project = Medium: High
|  |  |  |  |  |  Project = Low: null
|  |  |  |  |  Count-Test-P = Very Height: Very High
|  |  |  |  |  Count-Test-P = Height: null
|  |  |  |  |  Count-Test-P = Medium: High
|  |  |  |  |  Count-Test-P = Low: null
|  |  |  |  Final = Height
|  |  |  |  |  Project = Very Height: Very High
|  |  |  |  |  Project = Height: Very High
|  |  |  |  |  Project = Very Low: null
|  |  |  |  |  Project = Medium: null
|  |  |  |  |  Project = Low: null
|  |  |  Count-P-test = Medium: Medium
|  |  |  Count-P-test = Very Low: null
|  |  |  Count-P-test = Height
```

Fig. 6 (a) Results of ID3

```
J48 pruned tree
------------------

Count-assign = Very Height
|   Count-P-test = Very Height
|   |   In-Class = Very Height
|   |   |   Final = Low: High (5.0/1.0)
|   |   |   Final = Very Low: Very High (0.0)
|   |   |   Final = Medium: Very High (31.0/14.0)
|   |   |   Final = Height: Very High (5.0/2.0)
|   |   In-Class = Height
|   |   |   Midium = Low
|   |   |   |   Final = Low
|   |   |   |   |   Project = Very Height: Medium (2.0)
|   |   |   |   |   Project = Height: Medium (6.0/2.0)
|   |   |   |   |   Project = Very Low: Medium (0.0)
|   |   |   |   |   Project = Medium: Medium (1.0)
|   |   |   |   |   Project = Low: Medium (0.0)
|   |   |   |   Final = Very Low: High (0.0)
|   |   |   |   Final = Medium: High (11.0/1.0)
|   |   |   |   Final = Height: High (1.0)
|   |   |   Midium = Medium: Very High (7.0/2.0)
|   |   |   Midium = Height: Medium (0.0)
|   |   |   Midium = Very Low: Low (3.0/1.0)
|   |   In-Class = Medium
|   |   |   Final = Low: Low (2.0)
|   |   |   Final = Very Low: High (0.0)
|   |   |   Final = Medium
|   |   |   |   Midium = Low: Medium (3.0/1.0)
|   |   |   |   Midium = Medium: Medium (2.0)
|   |   |   |   Midium = Height: Medium (0.0)
|   |   |   |   Midium = Very Low: Medium (0.0)
|   |   |   Final = Height: Medium (0.0)
```

Fig. 6 (b) Results of J48

The table II shows that ID3 has the correctly classified accuracy of 83.9161% and J48 has the accuracy of 68.5315%. And the table III presents the classifier accuracy by class.

TABLE II
CLASSIFIER ACCURACY

Algorithm	Correctly Classified Instance	Incorrectly Classified Instances
ID3	83.9161 %	16.0839 %
J48	68.5315 %	31.4685 %

TABLE II
CLASSIFIER ACCURACY BY CLASS

Algorithm	Class of Student Motivation Behavior	TP Rate	FP Rate
ID3	VERY HIGH	0.571	0.007
	HIGH	0.64	0.059
	MEDIUM	0.8	0.073
	LOW	0.96	0.034
	VERY LOW	0.75	0.008
J48	VERY HIGH	0.429	0.015
	HIGH	0.88	0.136
	MEDIUM	0.4	0.016
	LOW	0.76	0.051
	VERY LOW	0.65	0.057

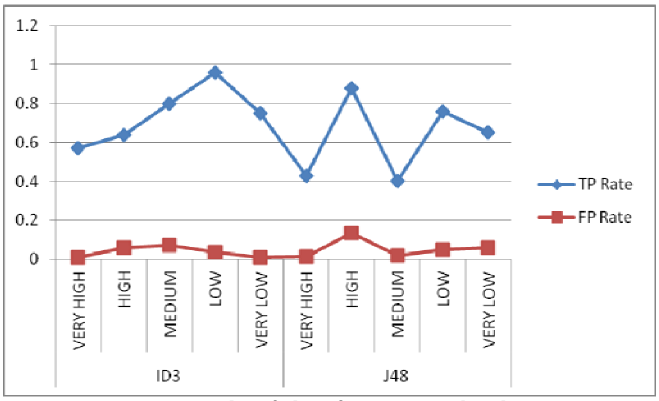

Fig. 7 Results of classifier accuracy by class

V. CONCLUSION AND FUTURE WORK

In this paper, we show the data mining techniques can be useful to model the student behavior outcomes and the preliminary result presents a promising progress in this prototypes model for the ongoing improvement of e-Learning course.

This model can be beneficial to similar courses to share and discover students' motivation behavior. However, in term of the future experiments, we are looking forward to research about other data mining techniques to enhance this project and also apply the tool to help teachers in their class.

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