Designing Student Motivation Modeling System for Adaptive E-Learning using Naive Bayes Classifier

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Abstract. Computer Aided Education (CAE) is one of information technology application in education. CAE was first introduced in the early 1960s at Stanford University by professor psychology Patrick Supper and Ricard C. Atkinson with their experiments used computers to teach math and reading to elementary school students in East Palo Alto, California. The practice of applying e-learning in universities is limited to accommodate the tasks and materials for teachers, whereas with the paradigm of quality education and Student Centered Learning (SCL), E-Learning is required to support both teacher and student. So, E-Learning must also be able to understand students and present the material in accordance with the needs of students. This study aims to develop Adaptive E-Learning uses students’ motivation as a variable. Students’ motivation is modeled by using Naïve Bayes Classification, the result of the test is 96.34 % accurate. The results of this modeling are then used as variables in the rule-bases of the material content system in determining the adaptive material presentation to the needs of the students. Based on the accuracy of test results system developed in the research is expected to be an E-Learning solution that supports the paradigm of quality education and Student Centered Learning (SCL).

Keywords—adaptive e-learning, student modeling, motivation modeling

1. Introduction

Learning Technology (LT) used for support learning includes broad and diverse technologies(Chen, 2013). One form of application of this technology is Computer Assisted Learning (PBK), as a driver to achieve a better learning process[2].

CPB was first introduced in the early 1960s at Stanford University by professor psychology Patrick Supper and Ricard C. Atkinson through his experiments using computers used to teach mathematics and reading to elementary students in East Palo Alto, California [2]. In practice in the field the application of e-learning in schools is limited to being used to accommodate the tasks and material from the teacher. However, along with the paradigm of quality education and Student Centered Learning (SCL), it takes an e-learning that can support the creation of a current educational paradigm.
SCL includes Problem, Project and Inquiry Based Learning. The three learning models require direct student involvement in learning activities [3](Kamaei, 2013)[4](Li, 2009)[5](Etikasari, 2016)[6](Dewanto, 2018)[7](Agustianto, 2016)[8](Destarianto, 2018). As part of the implementation of the SCL this study aims to develop Adaptive E-Learning based on modeling student motivation.

2. Related Work

2.1 E-Learning

E-learning is a very important part of the future, M. Mumbai and O. Support [10]based on research on several LMS such as Moodle, explaining applications that can be used by various e-learning that can used for free, but in this paper it is explained that most existing LMS still support the ability of the general, or in other words is not devoted to implementing a particular learning model. The application of e-learning as an LT used to support education includes broad and diverse technologies[1]. One form of application of this technology is PBK as a driver to achieve a better learning process [2], as a driver, the position of e-learning is as a companion to the learning process. As a companion to the learning process, e-learning must be able to provide a positive stimulus to student learning processes and outcomes[11] N. Noic-bozicdkk. [12]find BL implementation with PBL implementation in it using LMS AHYCo. It was proved that the use of BL (a combination of e-learning with a problem-based learning approach) not only made students more receptive to learning, but also able to improve their academic performance, Meejalemu's research [11]proved the same. This study aims to develop E-Learning which is able to provide stimulus to students by adjusting the needs of students' motivation through modeling.

2.2 Adaptive Learning

Adaptive Learning is the ability of the system to suit the needs of students. Basically, every human being is a unique individual, meaning that each has different characteristics from one another [8]. Recognizing students as a whole is the ultimate goal of student modeling, this study aims to model two aspects of students: learning motivation [9]and critical thinking skills[7]. Both of these aspects will be modeled and rules will be developed that are able to provide learning models that are compatible with the characteristics of motivation and critical thinking skills / adaptive learning models.

2.3 MotivasiBelajarMahasiswa

Motivation is defined as a person's motivator or motive that aims to satisfy a goal. Motivation is seen as a chain of reactions that starts from the need, then the desire arises to satisfy it (achieve the goal), thus giving rise to psychological tension that will direct behavior to the goal (satisfaction)[13][14][15].

Characteristics of students' learning motivation in achieving maximum learning outcomes are expressed by[16]namely: (1) working hard; (2) hope for success; (3) concerns will fail; and (4) competition. Based on the understanding and characteristics of learning motivation that has been described, the indicators that will be used in measuring students' learning motivation are shown in Table 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Indicator</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Work hard</td>
<td>Trying to complete the task with the best results</td>
</tr>
<tr>
<td>2.</td>
<td>To be responsible</td>
<td>Able to take responsibility for yourself and determine the future</td>
</tr>
<tr>
<td>3.</td>
<td>Need feedback</td>
<td>Requires regular feedback on progress and achievements</td>
</tr>
<tr>
<td>4.</td>
<td>Worries will fail</td>
<td>Tend to choose a task with moderate degrees of difficulty that makes it possible to succeed</td>
</tr>
<tr>
<td>5.</td>
<td>The desire to excel</td>
<td>Innovative and creative by looking for opportunities and using opportunities to show their potential</td>
</tr>
</tbody>
</table>
6. like the challenge       Happy for competitive activities

2.4 State of The Art
The application of learning methods to computer science students must consider the three components of the learning process namely student learning styles, motivation during the learning process and efficiency in education[17]. Based on the research, it is natural that there are many studies related to motivation and thinking ability.

Research[18] developed a learning model to generate students' initial motivation to complete projects in the form of teamwork. The study of learning motivation was also carried out by Chin Kai-Yin, Lee Ko-Fong, Chen Yen-Lin (2015). Research[19] develops a prediction system that can increase student motivation to try to learn. Research [20] developed a system to predict vocational student achievement based on his motivation.

The development of critical and creative thinking can be developed during the learning process especially for vocational education because the existing technology continues to develop. Research[21][22][23][24][25][26][27] that IT industry students need the development of creative ideas in software development design. The ability approach that must be possessed by IT students is the ability to solve abstract problems and logical thinking.

Naïve Bayes modeling techniques are also used by [28] to develop a prediction system for student placement in a particular field of focus. In addition to the determination of student placement, the naïve Bayes algorithm is also used by[29] in determining the level of knowledge of vocational students, the naïve Bayes technique shows better accuracy results than other data mining techniques such as regression, decision tree, and neural network. [30][31][32][33].

From the above research, it can be concluded that learning motivation and critical thinking ability are important components of students. This study aims to develop an adaptive system for computer engineering students in universities, using the corresponding learning model based on the results of motivation modeling and critical thinking skills.

3. Research Method

The research method used in this study begins with Literature Review Figure 1, this stage is used to view the position of the research, this stage will be carried out throughout the research. The advanced
stage of this section is the preparation of research, this preparation consists of observation and data collection activities supporting the beginning of the study.

This study is modeling the level of motivation of students, this level of motivation will be used as the basis for determining treatment on E-Learning. The form of modeling carried out by taking data from the questionnaire instrument, the results of input/questionnaire will be obtained by data mining techniques to produce classes of students' level of motivation. The results obtained at this stage will be validated by experts.

The expert will validate the results of the mining process, the results of which have been validated will then be used as a Knowledge Based (KB) system. These results will then be further processed to determine the appropriate treatment type, the method used in this study is to represent expert knowledge into the table rule. So that the determination of decisions produced by the system can provide an overview that is in accordance with the conditions of students and provide appropriate treatment.

After the testing process is done, the stages are followed by the development of E-Learning, the development process will be guided periodically by experts in education. The steps taken by the study were chosen to ensure that the system was well developed and truly capable of representing experts. The next step is the process of analysis and discussion.

The stages of analysis and discussion will discuss the process of testing, making, and evaluating the research. This stage will produce the value of validity and reliability and the accuracy value of the output of the system. The results from the system will be assessed using the ground truth approach, namely by comparing the output of the system with the results of expert research. Outputs that have been validated according to experts are considered valid data, which is also used as a measurement variable for the accuracy of the system. The last stage of this research is to make conclusions, which measure the level of research so that it can conclude whether or not the objectives of the research are achieved.

4. Result and Discussion

The results of the trial were carried out by the research using respondents from PoliteknikNegeriJember students. The trial conducted by the research was divided into two stages, the first stage was testing using a questionnaire, and this instrument was an instrument used to see the level of student motivation. The first stage in this study was processed with a statistical approach, shown by equations 1 and 2, the results were in the form of classes which were then used as KB systems. At this stage the research also combines the types of motivation with the appropriate learning model.

\[
\begin{align*}
    r_{xy} &= \frac{n \sum XY - (\sum X)(\sum Y)}{\sqrt{n \sum X^2 - (\sum X)^2} \sqrt{n \sum Y^2 - (\sum Y)^2}} \\
    r_{xy} &= \frac{74 \times 51482 - 26 \times 13550}{\sqrt{74 \times 1107 - 26^2} \sqrt{74 \times 2507074 - 1107^2}} = 0.33015
\end{align*}
\]

\[
\begin{align*}
    r_i &= \frac{k}{(k-1)} \left[ 1 - \frac{\sum \sigma_i^2}{\sigma_i^2} \right] \\
    r_i &= \frac{74}{(74-1)} \left[ 1 - \frac{45}{350.799} \right] = 0.882
\end{align*}
\]

\[
\begin{align*}
    \sum \sigma_i^2 &= 45 \\
    \sigma_i^2 &= \frac{\sum \text{total}^2 - (\sum \text{total})^2}{74} \\
    \sigma_i^2 &= \frac{2507074 - 13550^2}{74} = 350.799
\end{align*}
\]
This learning model is linked to the use of expert opinion representation, meaning that research submits rules or relationships between motivation and learning models to education experts. This merging process produces rules that will then be used by the system to make decisions.

The results of the first testing process are then used as input from the system, this is because the system developed is in the form of supervised learning / NBC, shown by Equation 3. While the rules resulting from expert opinion replication are used as rule expert systems. The test results performed using the application show an accuracy rate of 96.34%. Complete testing results can be seen in Table 2.

\[ p(A|B) = \frac{p(B|A) \times p(A)}{p(B)} \]  

(3) [34]

<table>
<thead>
<tr>
<th>V1</th>
<th>V11</th>
<th>V12</th>
<th>V23</th>
<th>Class</th>
<th>Tool</th>
<th>Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
<td>4</td>
<td>81</td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>3</td>
<td>85</td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>80</td>
<td>H</td>
<td>H</td>
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<tr>
<td>3</td>
<td>4</td>
<td>3</td>
<td>80</td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>3</td>
<td>86</td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
</tbody>
</table>

From the results of testing conducted by the study concluded that the system has been able to produce accuracy with an error rate below 5%, this means that the system is suitable for use. An error rate of 5% may be used in the field of education, in contrast to health research which gives a lower error value. The results of the tests also prove that the system developed can be used and is expected to contribute to education in Indonesia.

5. Conclusion
The accuracy value produced by the study reflects the success of the research to produce systems that represent experts. With the success of the system represents experts, basically research has been able to develop a good system, so that the spread of the system can also be similar. 96.34% accuracy value, which is obtained by testing ground truth, meaning that the system output is compared with the results of expert evaluation, the comparison of the two results in system accuracy.

This high accuracy value, becomes the capital for research to reach the conclusion of whether or not the objectives of the research are reached. With an accuracy of 96.34%, modeling students' motivation has been able to accurately describe the condition of students, then the developed expert system is also able to represent experts well. So of course the research objectives to produce a system that can improve the quality of education in Indonesia can be achieved. Based on the accuracy of test results system developed in the research is expected to be an E-Learning solution that supports the paradigm of quality education and Student Centered Learning (SCL).

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