Design of Student Modeling System to Support Adaptive E-Learning

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Design of Student Modeling System to Support Adaptive E-Learning

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Abstract. Based on the results of the study, it was found that the practice of using E-Learning at Politeknik Negeri Jember was only used to distribute material and collect assignments, even though there was an exam function which was widely used during the pandemic. However, the implementation of E-Learning like this is far from the learning concept being implemented by the institution, namely student-centered learning (problem and project-based learning). This study used learning motivation variables indicated by the students' interaction with E-Learning for clustering (K-Means) and classification (Naive Bayes). The results of the research showed that the accuracy value was 91.66%. As a result, the researchers are optimistic that the results of this study can be used to optimize the learning process at Politeknik Negeri Jember.

Keywords: Student modeling, k-means, NBC.

1 Introduction

Learning Technology (LT) [1] has attracted a lot of attention, especially during the pandemic. Based on the results of the pilot study it was found that the practice of using E-Learning at Politeknik Negeri Jember tended to be used only to distribute material and collect assignments, even though during the pandemic there was an exam functi which was widely used, this research is in line with the research that has been done by [2]. However, the implementation of E-Learning like this is far from the learning concept that is being implemented by Politeknik Negeri Jember, namely student-centered learning (problem and project-based learning) [3][4][5][6][7][8][9]. It is the students' right to have student-centered learning, in which they directly experience the learning. Since the learning focus is on students, the lecturer's role is to be a companion who have the ability to recognize each individual student. The demand to recognize each student become a challenge for the teacher, especially with the high number of activities carried out. In the context of Politeknik Negeri Jember, there is an additional problem, in terms of a large number of students. Thus, this study aimed to solve this problem through student modeling which was then integrated with e-earning (adaptive e-learning).

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Research conducted by [10] tested the level of motivation at a university using the RIMMS approach, This method aims to develop a new questionnaire to assess the level of student motivation. Research conducted by [11] developed M-Learning which was used to kinematically evaluate students' motivation levels. Research that is closely related to the pandemic period, research conducted by [12] which aims to identify the relationship between motivation and programming courses. These studies attempt to model student motivation to recognize students well. Research conducted by [13] produced quite interesting data, where in the study there were no significant differences in the use of 11 different learning methods on children's motivation, but the best of the methods were in-depth discussions and practice. This study aimed to be able to identify student motivation using indicators of ability to work hard, responsibility, feedback, fear of failure, desire to excel and challenge. This study used instruments that were developed in previous research, but the focus of this research was to model the interaction patterns between students and E-Learning.

This study was based on modeling student motivation by forming variables from the students' interaction with the e-learning, interactions that occurred, and rules that were subsequently used. It aimed to develop adaptive e-learning classification. The modeling was done by creating variables formed from the students' interaction with the e-learning, in terms of the ability to work hard, responsibility, feedback, fear of failure, desire to excel and challenge. The system which is the aim of the research is to model students using a naive Bayesian classification algorithm and the system produced a value ($prior$), used as the determinant of subsequent values. The result showed an accuracy of 91.667% with an error rate of 8.3%, from these results the research is optimistic that the results of this study can be used to optimize the learning process at the Jember State Polytechnic.

2 Research Methods

The research methodology is shown in Figure 1. The research used references as the basis for system development. However, since the system also implemented instruments which must be validated first (validation and reliability), the researchers did not develop new instruments but rather changed the existing instruments digitally.

At first, the data generated by the instrument (which das been tested in the previous research) were pre-processed; this stage was intended to eliminate anomalous data. The method used was NCL [14][15]. The data that went through the pre-processing process was considered normal data. It was then processed with K-Means to see the pattern of distribution. In this study, three clusters were used to determine the distribution of groups emerged from the normal data. If the clustered data showed an even distribution, the next step was to classify it.

The classification method used in this study was Naive Bayes [16][9], the selection was based on the research conducted by [8]. Thus, it is expected that the system can read and then classify quickly and accurately. The results obtained were then validated by education experts.

The validation carried out by the experts was in the classification results, produced for the model of the relationship between students and e-learningthen used as the basis for the analysis and conclusions of the study.

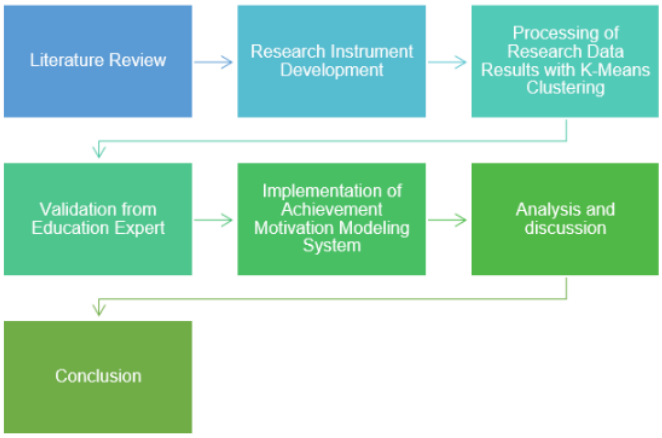

Fig. 1. Research Methodology

4 Results and Discussion

The data collection was carried out in several stages; broadly, it was divided into two. The first data collection was intended for initial testing of the system. At this stage, the data was used to see the suitability of the questionnaire and the suitability of the algorithm for data accuracy (algorithm accuracy). The next data collection was used to test the data from the present study. The population involved in this study were 192 JTI students who were determined by purposive random sampling technique. This random data collection aims to produce research data that meets statistical aspects, but still pays attention to the objectives of the research, this approach is based on the book [17]. The test results taken from the instrument showed an r table = 0.263 and alpha value = 0.867, indicating that the instrument was valid and reliable. The data obtained is then processed using SPSS, this processing is to ensure that the instrument is valid and reliable even though the questionnaire used actually comes from [motivation] research, the r table and alpha values are only used as reinforcements, in this study actually this section can be skipped because used a questionnaire from the research [9]. However, these results reinforce the results of previous studies which state that the questionnaire is valid and reliable. Armed with valid and reliable instruments, research can be considered using reliable data, this data will then be processed using WEKA. WEKA itself is an application devoted to analysis by implementing data mining and clustering, according to what was done in this study.

In this study, the researcher used K-Means, an unsupervised algorithm, to find multiple clusters (K) based on certain criteria. First, some cluster initials were selected as focal points. The data were then grouped based on centroid by calculating the shortest distance to the centroid. The distance formula used was the Euclidean distance, in which there are data X and Y with each vector $X = (x_1, x_2, ..., x_n)^T$, $Z = (x_1, x_2, ..., x_n)^T$. See equation (1, 2, and 3).

$$D = \left|\left|X - Y\right|\right| = [\sum_{i=1}^{n}(X_i - Z_i)^2]^{\frac{1}{2}}. \quad (1)$$

$$M_j = \frac{1}{N_j}\sum_{x \in S_j} X, N_j = \left|S_j\right|. \quad (2)$$

$$J = \sum_{j=1} \sum_{x \in S_j}^{n} \left|\left|X - M_j\right|\right|^2. \quad (3)$$

The data collection for clustering comprised 51 students and resulted in three clustering classes; cluster0, cluster1, and cluster2. K-Means Clustering was used in the present study to determine the class by calculating the included distance of each data point to the other data point. The clustering results validated by the experts showed cluster0 as moderate, cluster1 as low, and cluster2 as high, in terms of achievement motivation. The clustering result is shown in Figure 2.

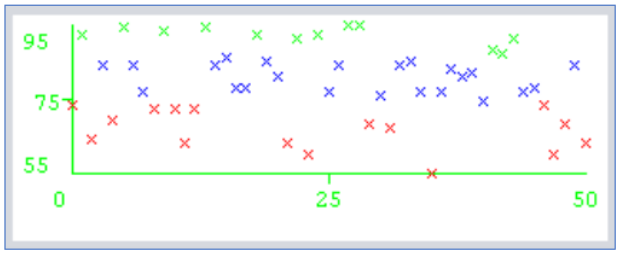

Fig. 2. Clustering

When implementing NBC, as shown by Equations 4 and 5, the system generated a value (*prior x likehood*), used as a determinant of subsequent values. When conducting research to remove the evidence value and modify the NBC formula, it was based on the assumption that the same events can be devalued. For example, values with the same denominator compare only the numerator value, as the denominator value may be dropped.

$$r_{xy} = \frac{n\sum XY - (X)(\sum Y)}{\sqrt{\{n\sum X^2 - (\sum X)^2\}\{n\sum Y^2 - (\sum Y)^2\}}}$$
$$r_{xy} = \frac{74 \times 51482 - 26 \times 13550}{\sqrt{(74 \times 1107 - 26^2)(74 \times 2507074 - 1107^2)}} = 0.33015 \quad (4)$$

$$r_i = \frac{k}{(k-1)}\left\{1-\frac{\sum {\sigma_i}^2}{{\sigma_t}^2}\right\}$$
$$r_i = \frac{74}{(74-1)}\left\{1-\frac{45}{350.799}\right\} = 0.882$$

$$\sum {\sigma_i}^2 = 45$$
$$ {\sigma_t}^2 = \frac{\sum total^2 - \frac{(\sum total)^2}{74}}{74} = \frac{2507074 - \frac{13550^2}{74}}{74} = 350.799 \quad (5)$$

The modeling implementation used a naive Bayesian classification algorithm and the system produced a value (*prior*), used as the determinant of subsequent values. The result showed an accuracy of 91.667% with an error rate of 8.3%. A visualization of the classification result is depicted in Figure 3. The classification result showed that the data were well classified into the three classes.

Correctly Classified Instances	176	91.6667 %
Incorrectly Classified Instances	16	8.3333 %
Kappa statistic	0.8673	
Mean absolute error	0.0659	
Root mean squared error	0.1962	
Relative absolute error	15.5793 %	
Root relative squared error	42.6632 %	
Total Number of Instances	192	

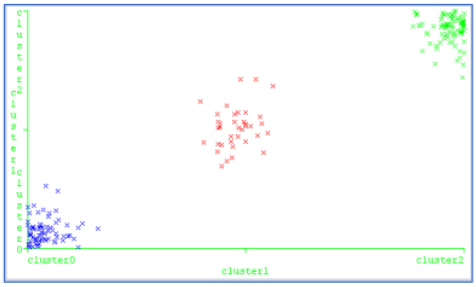

Fig. 3. Classification 10 fold

5 Conclusion

This study was based on modeling student motivation by forming variables from the students' interaction with the e-learning, interactions that occurred, and rules that were subsequently used. It aimed to develop adaptive e-learning classification. The modeling was done by creating variables formed from the students' interaction with the e-learning, in terms of the ability to work hard, responsibility, feedback, fear of failure, desire to excel, and challenge. After the interactions were identified, then a rule was formed and used for the classification process. The results showed an accuracy of 91.66%. In sum, the results of this study can be used to optimize the learning process at Politeknik Negeri Jember.

Acknowledgments

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