JHSS (Journal of Humanities and Social Studies)
https://journal.unpak.ac.id/index.php/jhss
Volume 09, Number 01, Page 310-315
e-ISSN: 2598-120X; p-ISSN: 2598-117X

PLACEMENT OF TEACHERS BASED ON SCHOOL NEEDS USING ITERATIVE DICHOTOMISER 3

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Article history: *received 21 January 2025; revised 02 February 2025; accepted 24 March 2025* *DOI: https://doi.org/10.33751/jhss.v9i1.11969*

Abstract. This research aims to develop an effective teacher placement model based on school needs using the Iterative Dichotomiser 3 (ID3) algorithm. The right placement of teachers can improve the quality of education and ensure equal distribution of human resources in the school environment. The ID3 algorithm builds a decision tree that helps determine optimal teacher placement. The research results show that using ID3 in the teacher placement process can produce more structured and fair decisions, compared to traditional methods. Test and Score results in 100x experiments, with the model or method used as Tree, showing that the AUC value is 0.950. The CA value is 0.934. The F1 value is 0.93. The Precision value is 0.934. The Recall value is 0.934. It is predicted that 1 subject teacher can teach the number of students per class in class 10 around 32 people, and class 11 around 31 people, and class 12 around 37 people. It is hoped that the implementation of this model can support educational policies in improving the distribution of educational quality in various classes and subjects.

Keywords teacher placement; school; ID3.

I. INTRODUCTION

Education is one of the key factors in the development of a country [1]. Teacher performance and competence have a great influence on the quality of education. In addition, the equitable distribution of teachers throughout schools also affects the quality of education. However, in many countries, including Indonesia, there is still an imbalance in teacher placement that causes some schools to lack qualified teaching staff, while others are overvalued. This inequality has a negative impact on student learning outcomes and the overall quality of education. Inappropriate placement can result in an imbalance in the quality of education between schools in different regions [2]. Therefore, a method is needed that can ensure that teachers are placed according to the needs of each school. The central government involves local governments in the management and supervision of education. One of the administrative authorities of local government education is in the Ministry of Education. Similar to Law Number 20 of 2003 concerning the National Education System, Article 41(3) states: "The government and local governments appoint educators and education personnel who are responsible for ensuring the implementation of quality education." [3]. Article 14 Paragraph 1 of the Regional Government Law Number 32 of 2004 stipulates that the implementation of education is one of the obligations, so it is one of the ways the central government regulates regional education in the education sector which is the authority of the local government [4], so that education is the main priority and receives special attention at the time of its implementation. Having the right teachers is essential for education. To ensure equity and quality of education, the government promulgated Law Number 14 of 2005 concerning Teachers and Lecturers, which in Article 24 Paragraph 3 states that comprehensive competencies to ensure the continuity of basic and early childhood education through authority-based formal education. [5]. The Central Kalimantan Provincial Education Office is an agency under the authority of the Central Kalimantan Provincial Government, with an agency that manages educational activities in Central Kalimantan Province. The number of districts/cities in the Central Kalimantan region is 13/1, the number of villages is 136, the number of villages/villages is 138/1,434, and the area is 153,564.50 km2 [6]. In 2016, the number of students in the Central Kalimantan region was 475,810 people, the number of teachers was 34,712, and the number of school buildings was 3,741 people. Due to the vastness of Central Kalimantan, the Provincial Education Office has to work hard to regulate education in the region. From the results of interviews with the Director of Supervision and the Director of Education of the Central Kalimantan Provincial Education Office, it can be seen that the number of teacher needs in Central Kalimantan Province is still very limited. This was conveyed because no new teachers were recruited

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e-ISSN: 2598-120X; p-ISSN: 2598-117X

and the number of teachers in the city was too much. For example, there are 11 public schools in Lamandau Regency with a total of only 140 teachers, while in Palangkaraya City there are 10 public schools with a total of 394 teachers. Of course, this is contrary to the competitiveness of each region and the mission of the Central Kalimantan Provincial Education Office to provide an easy-to-obtain and quality education. This is because there are still many teachers who only teach in metropolitan areas. So far, teachers in Central Kalimantan tend to choose teaching places in the city/district capital because of the geographical conditions and very lack of public facilities in remote areas, making schools in the outermost areas lack teaching staff.

Decision Tree learning is a method that seeks to find functions that have discrete value functions and are resistant to data noise [7]. This problem can be solved with the Iterative Dichotomiser 3 (ID3) method, which is a machine learning algorithm that aims to generate data-driven decisions. ID3 can help in identifying key factors to meet and optimize the teacher placement process.

Based on a number of studies that have been conducted [8], it can be concluded that the ID3 algorithm provides the best results. The same study was also conducted to test the performance of using multiple algorithmic decision trees [9]. Regarding student performance, the ID3 algorithm has also been successfully used in the formation of Decision Tree for student data who have passed lectures for the first year or two semesters. Learning outcomes are used to classify new students in need of matriculation [10]. Based on research conducted by [11], it is also proven that the prediction of the length of students' learning time with a precision score of 66.67 percent, recall 46.15 percent, and accuracy of 74.36 percent. In this study, the researcher applied the ID3 algorithm to analyze teacher data and school needs. By using this approach, it is hoped that a fairer and more effective teacher placement system can be created, so that it can improve the quality of education throughout Indonesia. This research also provides guidance for policy makers in making more informative and data-based teacher placement decisions. This study aims to evaluate the ID3 algorithm-based teacher placement model, as well as evaluate its effectiveness in creating equitable education and improving teacher performance. It is hoped that the results of this study can make a meaningful contribution to education policies and teacher placement practices in the future.

Teacher placement is the process of assigning and distributing teaching staff to various schools based on a number of specific criteria. These criteria can include individual performance, school-specific needs, teaching experience, subject specialization, as well as geographic and demographic factors [12] . The main objective of teacher placement is to ensure that each school has access to adequate and quality teaching resources, so as to support an effective and equitable teaching and learning process. Teacher placement is the process of placement between educational units, levels, types of education, districts/cities, and states, with the aim of determining the quality of education, and the placement of teachers between basic administrative units concerned in SKB 5 Ministerial Regulation of 2011[13].

Iterative Dichotomiser 3 (ID3) is a machine learning algorithm that works to build a decision tree. This algorithm deeply searches for all possible outcomes [14]. In 1986, Ross Quinlan developed this algorithm and it became one of the earliest and simplest methods for creating a decision tree from training data. ID3 can generate decision trees that can be used for data-driven decision-making, classification, and prediction [15]. The ID3 algorithm can be implemented using recursive functions. The ID3 algorithm tries to build a decision tree from top to bottom, and the training data is recursively divided into smaller parts (divided and conquered) when building the tree. A decision tree is a tree structure in which each tree node indicates the features being tested, each branch indicates a subdivision of the test results, and each leaf node indicates a specific class group [16]. The root node is the top node in the decision tree, and its attributes typically have the greatest impact on a particular class.

The advantages of ID3 are that they produce a decision tree that is easy to interpret, and ID3 is relatively fast for small to medium-sized datasets. While the limitations of ID3 tend to make a tree that is very specific to training data, which can reduce generalization capabilities. ID3 is more effective on categorical data; need modification or pre-processing for continuous data. Attributes with more unique values tend to be chosen because they can break down data faster, although it doesn't always result in the best separation.

Entropy is a measure in information theory that can determine the degree of impurity and uniformity of a data set, which is classified and tested for entropy values [17]. Then, the information gain (IG) value for each attribute is calculated from its entropy value.

Entropy(S)= p_+ 〖log_2 p〗 _+ -p_- log_2 p (1)

In the above entropy equation, entropy (S) is the number of bits required to represent a class, and its value is proportional to the number of bits that can be extracted by that class, the lower the entropy. For messages with probability, the ideal code length to display the information is bits. p-log_2 p

In the decision tree, entropy is used to measure the homogeneity of the data and helps to choose the best type of data separation, resulting in more accurate and efficient decision-making. Entropy is used to measure the uncertainty in a data set and helps in determining the most effective attributes in dividing the data.

Information gain serves to measure how well a feature separates data based on a specific class or label. In the context of decision trees such as the ID3 algorithm, information gain serves to determine the most informative attributes in dividing the dataset so as to reduce uncertainty or entropy [18]. A reduction in entropy generated by splitting datasets based on specific attributes. This reduction in entropy reflects the increased information obtained from

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dividing the dataset using the attribute [19]. The data obtained for attribute A is written as follows:

Gain(S,A)=Entropy(S) – Σ _(vE Value(A))▒(|S_V |)/|S| Entropy(S_V) (2)

Where A is the attribute; V is a possible value for the attribute A; Values (A) is a possible set for attribute A; is the number of samples for the value of V; :is the sum of the entire data sample; is the entropy for samples that have a value of v.|Sv||S|Entropy(Sv)

In information theory and machine learning, information acquisition is an important metric that measures how effectively a feature separates data sets by label or class. In the decision tree, information gain helps determine the best attributes for data sharing, leading to more accurate and efficient decision-making, model evaluation and model optimization.

Based on research [11] in a study entitled Classification system for student study duration on department of information systems at Musamus University, using ID3 also proves that the accuracy of data testing with the ID3 method which the data sample used is graduate data at the Department of Information Systems at Musamus University. The number of samples used was 131 with details of 92 training data and 39 test data. The results of this study are in the form of a system that uses the PHP programming language and MySQL database in its design. In the test, the ID3 algorithm in this study produced a prediction of the length of student learning time with a precision score of 66.67 percent, recall of 46.15 percent, and accuracy of 74.36 percent

Based on research [20] entitled Prediction system for student performance using data mining classification. As a result, overall student performance analysis system is proposed using classification data mining techniques to predict current student performance. A comparison of the C4.5, ID3 decision tree generation algorithm and the improvement of the ID3 algorithm was carried out. The improved ID3 algorithm provides better performance compared to the traditional ID3 and C4.5 algorithms.

Based on research [21] entitled Competency discovery system: integrating the enhanced ID3 decision tree algorithm to predict the assessment competency of senior high school students. As a result, the Competency discovery system integrates the Enhanced Iterative Dichotomiser 3 (ID3) algorithm for the assessment of high school students, focusing on identifying attributes that affect their performance. This system helps teachers improve students' academic and technical skills, identify potential talents and require support from the National Skills Assessment program. The system also helps students understand their potential for success and helps teachers manage their study time effectively. This approach benefits students by encouraging self-development and improving their performance.

Based on research [22] entitled PSAP: Improving Accuracy of Students' Final Grade Prediction using ID3 and C4. 5. The findings show respondents' views on aspects of interface design, functionality, navigation, and reliability of developed web-based applications. The results of the study also showed that the accuracy of the classifiers built using the ID3 classification model (C4.5) was 79.18 percent and was the highest compared to the Naïve Bayes and Generalized Linear classification models.

Based on research conducted by [23] entitled Optimization of ID3 Structure for Academic Performance Analysis using Ant Colony Algorithm. This study reveals that final exam scores are the most important indicator of students' academic performance in Programming 3 courses. Students with scores above 77.5 typically achieve higher performance classifications, while students who score 77.5 or lower tend to be categorized as moderate or poor. Midterm exam scores are very important for students with lower grades, while assignment scores are less significant. Decision trees optimized with Artificial Convolutional Neural Network (ACO) are suitable for academic performance analysis in educational settings. The ACO-ID3 provides a clear classification and can help identify the key factors that affect student performance. It can be used to identify students who need additional support and develop effective teaching strategies.

II. RESEARCH METHODS

This study aims to evaluate the teacher placement model based on school needs using the Iterative Dichotomiser 3 (ID3) algorithm. This study uses an experimental method with a quantitative approach. This approach was chosen to measure the effectiveness of the ID3 algorithm in teacher placement and to obtain objective results based on existing data. Figure 1 shows the design of the study. The data sources of this study include teacher performance databases (including teaching evaluations, competency test results, participation in professional development, and feedback from students) and school needs data (including student-teacher ratios, subjects taught, geographic location, and school demographic conditions)

The data collection techniques used are documentation (official documents such as teacher performance reports, school data from the education office, and surveys), as well as interviews, questionnaires and observations to obtain accurate, relevant, and relevant data to the problem being researched. Interviews are a process to obtain information that aims to achieve research by conducting questions and answers to respondents and parties related to the research. The questionnaire was collected through the dissemination of a list of questions to respondents about the research topic. Observation of data collection by going directly to the research location to obtain the desired data related to the research.

Next, Data Transformation, by encoding categorical data into numerical formats that can be processed by the ID3 algorithm, and by dividing the dataset into subsets of training and testing for model validation.

The implementation of the ID3 Algorithm is by building a decision tree using the ID3 algorithm by looking at the

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e-ISSN: 2598-120X; p-ISSN: 2598-117X

processed data, and using entropy and information gain to select the best attributes for each node in the decision tree. ID3 Algorithm Steps:

1. Start with the entire dataset as root by calculating the entropy of the entire dataset. For each attribute, calculate the entropy of the condition for a subset of data divided by the value of that attribute.
2. Select the Best Attribute, by calculating the gain of information for each attribute. Then, select the attribute with the highest information gain as the decision-making node at that level.
3. Divide the dataset into subsets based on the value of the selected attribute. For each subset, repeat the process recursively to create the next decision node, using that subset of data.
4. Condition Stops, if
   a. All instances in the subset have the same label (zero entropy).
   b. There are no more attributes to choose from.
   c. Empty datasets or remaining attributes don't provide significant information gain.

Then, analyze the results of the model evaluation to identify patterns and trends, and then interpret the results in the context of education policy and practical implications for teacher placement. Also, concluding the main findings of the research and assessing the success of the ID3 model in teacher placement.

III. RESULT AND DISCUSSION

The results of the data analysis provide some information such as teacher suitability and student ratios in each group. Strategic issues are addressed through the selection of policy options. The following principles form the basis of this policy. First, focus on the needs of students, not on the needs of teachers. Second, increasing learning efficiency. Third, reduce educational disparities within and between school districts. Fourth, increasing the utilization and efficiency of educational resources.

Based on the results of the data collection carried out, then the data is processed with Orange Data Mining Software as an analysis aid software to be further analyzed using the Iterative Dichotomiser 3 (ID3) method, which can be seen in Figure 1.

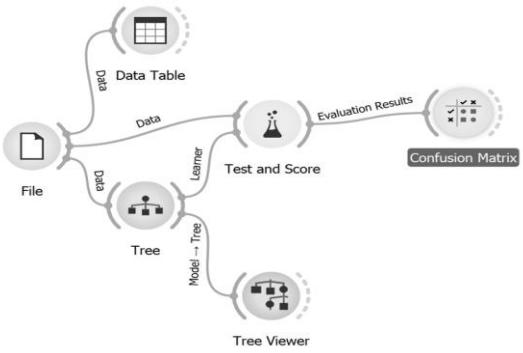

Figure 1 Orange Software Display with Iterative Dichotomiser 3 Method (ID3)

Once the file is entered, the data can be viewed in the Table Data. It was identified that the number of schools in Central Kalimantan is 239, consisting of 58 private schools and 181 public schools and there are 3044 civil servants, consisting of 254 non-permanent teachers and 2790 state civil servants. Details are in Figure 3. Based on the results of the data collection carried out, it is also known that the number of State High Schools in Central Kalimantan is 181 pieces, with a total number of Learning Groups (Rombel) of 1886 pieces consisting of Class X Science as many as 205 pieces, Class X Social Studies as many as 335 pieces, Class X LANGUAGE as many as 10 pieces. And Class XI Science as many as 286 pieces, class XI Social Studies as many as 340 pieces, and XI LANGUAGE class as many as 11 pieces. As well as class XII Science as many as 268 pieces, XII Social Studies as many as 325 pieces, and class XII LANGUAGE as many as 9 pieces. With a total number of students of 50,914 people. The comparison of the number of teachers from 2016 to 2023 has also increased in each subject by approximately 20 percent.

The adequacy of subject matter teachers in Central Kalimantan can be calculated by comparing the number of experts in each subject and the number of subject teachers needed. It can be concluded that the number of subject teachers in how many schools is sufficient, it can be concluded that the number of experts in each subject is more than the number of subject teachers. For PPKN subjects, the number of teachers distributed is around 43 people. For Islamic subjects, the number of teachers distributed is around 96 people. For Catholic subjects, the number of teachers is more than 22 people. For Christian subjects, the number of teachers is distributed around 60 people. For Hindu subjects, the number of teachers is more than 35 people. For Buddhist subjects, the number of teachers is distributed more than 1 person. For Indonesian subjects, the number of teachers distributed is around 75 people. For the Mathematics subject, the number of teachers distributed is around 70 people. For English subjects, the number of teachers distributed is around 110 people. For the Physics subject, the number of teachers distributed is around 58 people. For Biology subjects, the number of teachers distributed is around 65 people. For the subject of Economics, the number of teachers distributed is around 63 people. For the subject of Sociology, the number of teachers distributed is around 20 people. For the Chemistry subject, the number of teachers distributed is around 35 people. For PJOK subjects, the number of teachers distributed is around 90 people. For the History subject, the number of teachers is more distributed around 29 people. For the subject of Cultural Arts, the number of teachers is more distributed around 9 people. For the Entrepreneurship subject, the number of teachers is more than 2 people. For the Geography subject, the number of teachers distributed is around 25 people. For Arabic subjects, the number of teachers is more than 4 people. For German subjects, the number of teachers is more than 2 people. For French subjects, the number of teachers is more than 2 people. For Japanese subjects, the number of teachers is distributed more than 1 person.

After that, input the Tree and connect it to the File and input the Tree Viewer and connect it to the Tree to view the

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Iterative Dichotomiser 3 (ID3) tree. The results show that students of the science class are distributed 45,546 percent, and students of the social studies class 53.22 percent, while students of the LANGUAGE class are only 1.59 percent. Details are given in Figure 2

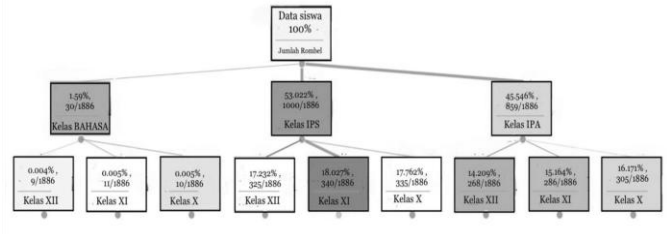

Figure 2.Tree Viewer ID3 Images

After that, enter the Test and Score and connect it with the File and Tree and the Confusion Matrix input and connect it to the Test and Score for the Iterative Dichotomiser 3 (ID3) tree matrix analysis . The Test and Score results in the 100x experiment, with the model or method used is Tree. AUC is a prediction stored in the use of the model. In Figure 7 the results show that the AUC value is 0.950. The CA value is 0.934. F1 is a balanced average of precision and memory. The F1 value is 0.93. while Precision is the receiver's ability not to label a negative sample, or the receiver's ability not to negatively label a positive sample. The Precision value is 0.934. While Recall is the ability of classifiers to find and classify positive samples. The Recall value is 0.934. This is shown in Figure 3.

Model	AUC	CA	F1	Precision	Recall
Tree	0.950	0.934	0.934	0.934	0.934

Figure 3. Test and Score Results

Confusion Matrix results to show the actual results and predictions between class X, class XII, and class XII. The results can be seen in Figure 9. As a result, there were 25 subjects with different lesson weights. It is predicted that 1 subject teacher can support the number of students per class in grade 10 around 32 people, grade 11 around 31 people, and grade 12 around 37 people. The Confusion Matrix condition is an ideal result, where it is assumed that compulsory subjects and specialization subjects are weighted equally, without considering the student's specialization. The reason why Orange data mining on this Tree uses Test and Score and Confusion Matrix is because the Decision Tree algorithm is still a classification method.

IV. CONCLUSION

Based on the results of data collection and data processing with Orange Data Mining Software to be further analyzed using the Iterative Dichotomiser 3 (ID3) method, it was identified that the number of schools in Central Kalimantan was 239, consisting of 58 private schools and 181 public schools and there were 3044 civil servants, consisting of 254 Non-Permanent Teachers and 2790 State Civil Servants. It is known that the number of State High Schools in Central Kalimantan is 181 pieces, with a total number of Study Groups (Rombel) of 1886 pieces consisting of Class X Science as many as 205 pieces, Class X Social Studies as many as 335 pieces, Class X LANGUAGE as many as 10 pieces. And Class XI Science as many as 286 pieces, class XI Social Studies as many as 340 pieces, and XI LANGUAGE class as many as 11 pieces. As well as class XII Science as many as 268 pieces, XII Social Studies as many as 325 pieces, and class XII LANGUAGE as many as 9 pieces. With a total number of students of 50,914 people. The number of subject teachers in how many schools can be concluded that the number of experts in each subject is more than the number of subject teachers. The results of the Tree Viewer from the Orange Data Mining Software show that 45,546 percent of science class students are distributed, and social studies students 53.22 percent, while LANGUAGE class students are only 1.59 percent. The results of the Test and Score on the 100x experiment, with the model or method used are Tree indicating that the AUC value is 0.950. The CA value is 0.934. The F1 value is 0.93. The Precision value is 0.934. The Recall value is 0.934. As well as the Confusing Matrix Results to show 25 subjects with different lesson weights. It is predicted that 1 subject teacher can support the number of students per class in grade 10 around 32 people, grade 11 around 31 people, and grade 12 around 37 people. The Confusion Matrix condition is an ideal result, where it is assumed that compulsory subjects and specialization subjects are weighted equally, without considering the student's specialization.

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