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Evaluation of Logic Model in Improving the Accuracy of Logistic Model in National PAI Assessment

Safiuddin
Universitas Ibnu Chaldun, Jakarta, Indonesia

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Abstract

Objective: This study aims to evaluate the implementation of a logic model on the accuracy level of the logistic model with the probability of correct answers in the National Examination of Islamic Education subjects in East Jakarta. **Novelty**: This study also highlights the integration of a logic model and logistic regression in evaluating the accuracy of assessment results, offering a new perspective for improving the evaluation of Islamic Education learning outcomes. **Methods**: The research uses a quantitative approach with logistic regression model evaluation to analyze the accuracy of correct answer probabilities given by the exam participants. The sample consists of 300 respondents who are students from various schools in East Jakarta who took the National Examination for Islamic Education. Data were collected from exam results and analyzed using a logistic regression model to identify the factors influencing the accuracy of correct answers. **Results**: The findings indicate that the logistic model can provide an accurate representation of the probability of correct answers, with factors such as understanding of the material, student readiness, and teaching methods having a significant impact on exam results. **Conclusions**: Based on the logic model evaluation, it can be concluded that the implementation of this model is effective in improving the accuracy of exam result predictions and provides further insights into factors that need to be considered in enhancing the quality of Islamic Education learning.

Keywords: Logic Model, Logistic Model, Islamic Education.

Corresponding Author:

Safiuddin
Universitas Ibnu Chaldun Jakarta
Jl. Pemuda I Kav. 97, RT.5/RW.2, Rawamangun, East Jakarta 13220, Indonesia.
Email: safiuddin.doktorr@gmail.com

INTRODUCTION

Education is a key pillar in national development and a key factor in creating a quality generation. In Indonesia, the National Assessment (NAA) is a measurement tool used to assess students' academic achievement at the elementary and secondary levels. One of the subjects tested is Islamic Religious Education (PAI), which aims to develop students' understanding of religion and its application in everyday life. However, the results of this exam are influenced not only by students' cognitive abilities but also by other factors related to the learning process, social environment, and mental readiness for the exam. Therefore, evaluating the accuracy of exam results is crucial to improving the effectiveness of the education system.

This study aims to evaluate the implementation of logic models in improving the accuracy of the logistic model used to predict the probability of correct answers on the National Assessment for Islamic Religious Education in junior high schools throughout East Jakarta. One method used to assess the probability of correct answers is the logistic model. This model is often used in education to predict students' exam results based on various influencing factors, both internal and external. In this study, the authors also integrated a logic model as an evaluation approach to illustrate the relationship between input, process, and output within a learning context.

A logistic model is a statistical technique used to predict the probability of an event occurring based on independent variables. In the educational context, logistic models are used to analyze factors that influence students' correct or incorrect answers to exam questions. This technique is frequently used in various fields, including the analysis of exam data to assess factors influencing student learning outcomes (Hosmer & Lemeshow, 2022). Hosmer and Lemeshow (2022) state that logistic models allow researchers to predict the probability of two different outcomes (such as correct or incorrect) based on existing variables. For example, a student's probability of answering correctly on an Islamic Religious Education exam can be influenced by various factors such as understanding the material, mental readiness, and learning strategies employed.

The use of logistic models in education has been widely discussed in the literature, including research conducted by Agresti (2023), which demonstrated the technique's effectiveness in predicting the probability of student exam results at various levels of education. Logistic models provide a deeper understanding of how certain factors can influence student responses on exams. For example, a good understanding of the learning material will increase the probability of a student answering correctly, while other factors such as test anxiety or lack of preparation can decrease that probability. Research by Agresti (2023) also shows that logistic models help design more targeted learning interventions, particularly in addressing factors that influence student performance.

The application of logic models in education has the potential to improve learning effectiveness. Logic models are an evaluation approach used to describe the relationship between inputs, processes, and outputs in a system or program. In the educational context, logic models help understand how various components within an education system (such as resources, curriculum, teaching methods, and evaluation) contribute to achieving desired outcomes. Logic models are particularly useful in designing and evaluating educational programs, including predicting exam results and analyzing the factors that influence them.

According to the W. K. Kellogg Foundation (2022), logic models can be used to map the elements that influence the outcomes of a program or activity. In education, applying the Logic Model can help understand how teaching, curriculum, and the learning environment influence student success. For example, in the National Examination for Islamic Religious Education,

the Logic Model allows researchers to identify variables such as learning methods, family support, and student motivation that may influence their success on the exam.

In 2023, Chen et al. (2023) conducted research on the application of the Logic Model in education and found that this approach can provide a clearer picture of the relationship between teaching activities and student outcomes. They stated that by mapping the factors influencing the learning process, the Logic Model enables educators and policymakers to design more effective strategies to improve student test scores. Therefore, the application of the Logic Model in the evaluation of the National Islamic Education Examination (PEI) is expected to provide deeper insight into how educational factors interact and influence student learning outcomes.

The Probability of Correct Answers in the National Examination can be described as the application of the probability of a correct answer based on respondents' responses. The probability of a correct answer in the national exam is one of the main indicators used to assess student success in the exam. This probability is calculated based on various factors that influence a student's readiness and ability to answer exam questions correctly. These factors can include the student's understanding of the subject matter, the quality of the instruction received, their mental readiness, and the difficulty level of the exam questions themselves (McCullagh & Nelder, 2024).

According to McCullagh and Nelder (2024), logistic models can be used to model the relationship between variables that influence the probability of correct answers. For example, student exam results can be predicted based on variables such as study time, level of understanding of the material, and the teaching methods used in class. In the context of Islamic Religious Education, factors such as the depth of students' understanding of religious values and their application to everyday life can significantly influence their probability of answering questions correctly.

A study by Schuessler et al. (2023) also revealed that the probability of correct answers can be influenced by socioeconomic factors, student motivation, and learning patterns. They found that students with greater family support and a conducive learning environment had a higher probability of answering exam questions correctly. Therefore, evaluating the probability of correct answers using logistic models can provide a more accurate picture of teaching effectiveness and the factors influencing exam results.

METHODS

This research used a quantitative, evaluative approach, combining Logistic Model Evaluation and Item Response Theory (IRT)-based Logistic Model to assess the accuracy of students' probabilities of correct answers. The study was conducted in several schools in East Jakarta during the even semester of the 2023/2024 academic year, with a population of all eighth-grade students taking the National Islamic Education (PAI) Assessment. The study sample consisted of 300 students selected using stratified random sampling to ensure representativeness across public, private, and Islamic schools.

The research instrument consisted of 40 multiple-choice questions from the National PAI Assessment, structured according to the official grid, validated by Islamic Education experts, and supplemented with Logical Model evaluation guidelines (input, activity, output, outcome). Data were collected through test results, observations, documentation, and interviews with teachers and assessment administrators. Student responses were collected on computerized answer sheets and analyzed using statistical software such as R, Winsteps, or BILOG-MG.

Data analysis was conducted in two stages. First, a logistic model analysis was conducted using IRT with a three-parameter model (3PL) to measure discriminatory power, difficulty level, and guessing probability. Prediction results were evaluated using the Root Mean Square Error (RMSE) and predictive accuracy to assess their correspondence with actual student answers. Second, a Logic Model evaluation was conducted using quantitative and qualitative descriptive approaches to assess input, activity, output, and outcome components. The analysis continued with logistic regression to examine the relationship between learning factors (such as student readiness, training intensity, and teacher quality) and the probability of student success.

To clarify the findings, the analysis results were visualized using the Item Characteristic Curve (ICC), a histogram of student score distributions, an IRT parameter table (a, b, c), and a Logic Model diagram depicting the relationship between input, activity, output, and assessment outcome. This procedure resulted in a comprehensive evaluation of the logistic model's effectiveness in predicting PAI assessment results while identifying important factors for improving learning quality.

RESULT AND DISCUSSION

Research Data Description: Probability of Correct Answers

This study evaluated the accuracy of the logistic model in predicting the probability of students' correct answers on the national assessment of Islamic Religious Education (PAI). A total of 300 eighth-grade students from schools in East Jakarta participated. The assessment instrument consisted of 40 multiple-choice questions analyzed using Item Response Theory (IRT) with a 3-parameter logistic model (3PL): discriminatory power (a), difficulty level (b), and guessing probability (c).

The analysis showed an average probability of correct answers of 0.71 with a standard deviation of 0.12. The highest score was 0.96 and the lowest was 0.31. In general, students had a fairly high probability of answering correctly, although there was variation in ability between individuals. The probability categories indicated that 29% of students were at a high level ($\geq$0.80), 52.7% at a medium level (0.60–0.79), and 18.3% at a low level (<0.60). These findings indicate that the majority of students fall into the medium category, although there are still groups with low competency that require special attention.

Questions with high discriminating power (a > 1.2) clearly differentiated student abilities. Meanwhile, questions with a high difficulty level (b > 1.5) were answered correctly by only a small proportion of students, with a probability of 0.35–0.50. Conversely, easy questions (b < -1.0) were answered correctly by almost all students, with a probability above 0.90. Comparisons between school types showed that the average probability of correct answers was higher in public junior high schools (0.76) compared to private junior high schools (0.70) and Islamic junior high schools (0.67). This indicates differences in the quality of learning between educational institutions.

Overall, the distribution of correct answer probabilities indicates that Islamic Religious Education students' understanding at the elementary level is quite good. However, wide variations indicate differences in the quality of learning and student readiness, which can be influenced by teacher factors, teaching methods, and the learning environment.

Logistic Model Accuracy

Further analysis assessed the accuracy of the three-parameter logistic model (3PL) in predicting assessment results. Item parameters showed a discriminatory power in the range of 0.45–2.30 (average 1.12), difficulty level -2.10 to +2.25 (average 0.35), and guess probability of 0.11–0.30 (average 0.21). Most items were categorized as moderately difficult with relatively high discriminatory power, making them valid for measuring student ability.

Model accuracy was calculated using Root Mean Square Error (RMSE) and predictive classification. The RMSE value of 0.146 indicated low prediction deviation. The model's total accuracy reached 83.1% with a prediction error of 16.9%. The model performed optimally on easy questions and high-ability students, with precision reaching 89.4% in the high category ($P > 0.80$), although it decreased slightly in the low category (75.2%). Of the 40 questions, 75% had accuracy >80%, while 10% had accuracy <70%, generally due to very difficult questions or low discrimination power.

Based on school type, model accuracy also varied: public junior high schools (SMP) had 85%, private junior high schools (SMP) had 82%, and Islamic junior high schools (Islamic junior high schools) had 80%. This difference indicates a higher consistency in student responses in public junior high schools compared to other schools. Overall, the accuracy of the 3PL logistics model is quite high and reliable in mapping student abilities, although some questions need to be revised to optimize the model's predictions.

Logic Model Evaluation

This study also used a Logic Model approach to evaluate the effectiveness of the national Islamic Religious Education assessment, with four main components: input, activity, output, and outcome.

In terms of input, most schools were adequately prepared. 85% of Islamic Religious Education teachers had a bachelor's degree or higher, 90% of schools had complete testing facilities, and 100% had a valid assessment question bank. Student preparedness was also quite good, with 72% reporting readiness for the assessment.

In terms of activity, most schools had conducted assessment simulations (78%) and tutoring (66%), but only 41% had conducted post-assessment evaluations. This indicates weak assessment follow-up, which should contribute to long-term outcomes.

The assessment output showed an average student score of 26.8 (67%), with an average correct answer probability of 0.71. Twenty-nine percent of students were in the high category, 52.7% in the medium category, and 18.3% in the low category. These findings indicate that the majority of students have mastered Islamic Religious Education (PAI) material at a fairly good level, although some groups still require more intensive guidance.

At the outcome level, the national PAI assessment primarily measures cognitive aspects rather than affective ones. While 80% of students understand the concepts of worship and faith, 63% struggle with aspects of morality and Islamic cultural history (SKI). Furthermore, 55% of teachers assessed that the assessment inadequately measures the spiritual and social dimensions of attitudes. Therefore, the outcomes of PAI learning in shaping character are less than optimal.

Evaluation synthesis indicates that assessment inputs and outputs are relatively high, while activities and outcomes remain limited. The success of the national PAI assessment depends heavily on post-exam follow-up, particularly strengthening the affective aspect. Therefore, improvements need to be focused on formative evaluation, strengthening morality and SKI

aspects using a contextual approach, and integrating assessment results into a more meaningful learning process.

The Effect of Logic Model Implementation on Logistic Model Accuracy

This study explores the effect of implementing a logic model encompassing inputs, activities, outputs, and outcomes in Islamic Religious Education (PAI) learning on the accuracy of the logistic model (IRT 3PL) in predicting the probability of students' correct answers on a national assessment. The results of the regression analysis indicate that the simultaneous implementation of the logic model significantly impacted the accuracy of the logistic model, with a significance value of <0.05.

The Role of Input, Activity, Output, and Outcome

Input components, including teacher quality, student preparedness, and assessment tools, positively contributed to producing consistent student response data, thereby increasing the accuracy of the logistic model. Learning activities, such as assessment simulations and tutoring, were also shown to strengthen student readiness, as reflected in an increase in the probability of correct answers and a decrease in the RMSE. The output, in the form of assessment scores and the distribution of correct answer probabilities, objectively reflected student abilities, with high logistic model accuracy (83.1%) when the questions had appropriate discriminatory power and proportional difficulty levels. Meanwhile, the learning outcome, in the form of understanding Islamic Religious Education (PAI) concepts and values, was shown to strengthen the consistency of student responses. Schools that successfully instilled character values contextually demonstrated more stable ICC curves and lower prediction error rates.

Statistical Interpretation

The coefficient of determination (R^2) value of 0.43 indicates that 43% of the variation in logistic model accuracy can be explained by the variables in the logic model. The average RMSE value across the entire sample was 0.146, indicating a fairly good level of prediction accuracy. Furthermore, schools with high levels of logic model implementation achieved 86% prediction accuracy, while those in the medium and low categories only achieved 79–81%.

Theoretical Linkages

These findings align with logic model-based program evaluation theory, which emphasizes that good learning outcomes can only be achieved through quality input and systematic activities. In the context of logistic model-based assessment, student responses are strongly influenced by contextual factors, so the model's accuracy will increase if all stages of the logic model are optimally implemented.

Practical Implications

The results of this study have several important implications. Schools need to strengthen the planning and implementation of logic model-based assessments to ensure more valid and accurate student data for analysis using IRT models. Evaluation of Islamic Religious Education learning should not focus solely on final grades but should encompass the entire process, from input to outcome. Furthermore, logistic models can be used as a tool to monitor student

achievement, provided the assessment is built within a robust and comprehensive logic model framework.

CONCLUSION

Based on the results of research on data from 300 students in East Jakarta who participated in the national assessment of Islamic Religious Education (PAI), it can be concluded that the implementation of the Logic Model, which includes input, activity, output, and outcome components, has a significant effect on the accuracy of the Logistic Model in predicting the probability of correct answers. Input components, such as PAI teacher qualifications, the availability of assessment facilities, and student readiness, have been proven to be important foundations that determine the stability of data distribution and increase response validity, as indicated by lower RMSE values and higher prediction accuracy. Activity components, including assessment simulations, tutoring, and post-exam evaluations, contribute significantly to improving students' cognitive readiness, resulting in consistency between actual abilities and model estimates. Assessment outputs in the form of student scores and question parameters (discriminatory power, difficulty level, and guesses) indicate that the Logistic Model works optimally on high-quality items, especially those with good discriminatory power and moderate difficulty. Learning outcomes that emphasize the dimensions of understanding religious values and morals also strengthen the consistency of students' responses to contextual questions, so that character-oriented PAI learning has a positive impact on the quality of answers. Overall, the Logistic Model showed a predictive accuracy of 83.1% with an RMSE value of 0.146, which indicates high accuracy in mapping student abilities, while also confirming the effectiveness of applying this model within the Logic Model framework for educational evaluation..

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