

Neuro-Symbolic AI for Education: How AI Impacts Student Performance in 2025 and Beyond

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Abstract

This project explores how Neuro-Symbolic AI can be applied to the education sector in 2025 to analyze and predict student success. We used a combination of a neural network model (for prediction) and symbolic logic (for explanation) to understand how AI usage, parental education, and other social factors affect student performance. The model not only predicts whether a student will pass or fail but also explains the reason behind each prediction using human-readable rules. Visualizations support our findings, and future directions are discussed.

1 Introduction

Artificial Intelligence (AI) is playing a transformative role in the field of education. In this study, we explore how AI usage—especially through tools like ChatGPT—affects student outcomes. The goal is not just to predict student performance, but also to explain the predictions clearly using Neuro-Symbolic AI.

2 What is Neuro-Symbolic AI?

Neuro-Symbolic AI combines two major types of AI:

In this project, the neural part predicts whether a student will pass or fail, while the symbolic part explains why using clear rules.

3 Dataset Description

We used the “Students Performance in Exams” dataset, which includes:

- Exam scores in Math, Reading, and Writing
- Gender

- Parental level of education
- Lunch type (standard or free/reduced)
- Test preparation course

We added a synthetic column:

- **AI Tool Usage (hours per week)** – Simulated values from 0 to 10

4 Methodology

4.1 Neural Part

We used a Multi-Layer Perceptron (MLPClassifier) from **scikit-learn** to predict whether a student would pass (average score ≥ 50) or fail. Input features included gender, AI usage hours, parental education, and more.

4.2 Symbolic Part

We defined human-readable symbolic rules such as:

- If **AI usage** ≥ 7 , then “High AI usage likely improved learning”
- If **Parental education** = Bachelor’s or Master’s, then “Parental education supports better outcomes”
- If **Lunch** = standard, then “Standard lunch linked with higher performance”

Each prediction from the neural network was explained using these rules.

5 Results and Explanation

Sample prediction and explanation:

Prediction: Pass

Explanation: High AI usage likely improved learning; Parental education supports better outcomes

The model achieved strong performance in predicting pass/fail, and symbolic rules made results understandable for educators.

6 Visualizations

7 Conclusion

This project demonstrates how Neuro-Symbolic AI can be used to not only predict student performance but also explain the reasoning behind each prediction. This combination of intelligence and explainability can be very useful in educational decision-making.

8 Future Work

Future versions of this work can include:

- Real-time classroom data from AI-based learning platforms
- More complex symbolic rules from expert teachers
- Predicting long-term learning outcomes, not just pass/fail