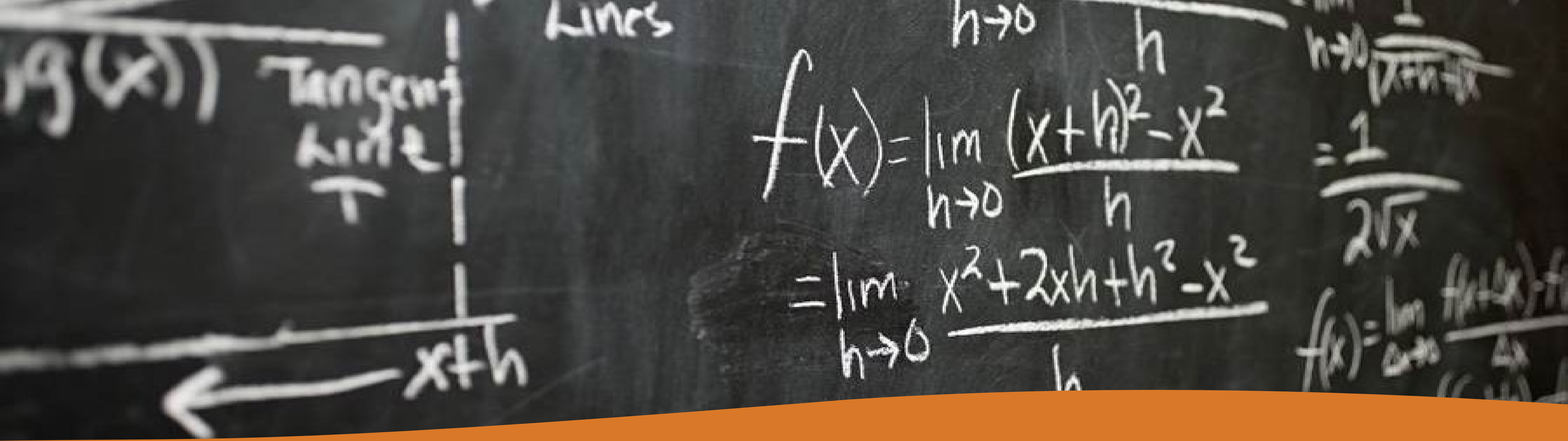

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AI Driven Prediction of Student Success in Engineering Mathematics: Integrating Course Performance, Academic Progression, and Mathematical Misconceptions

Presentation Overview

Why Mathematics Matters

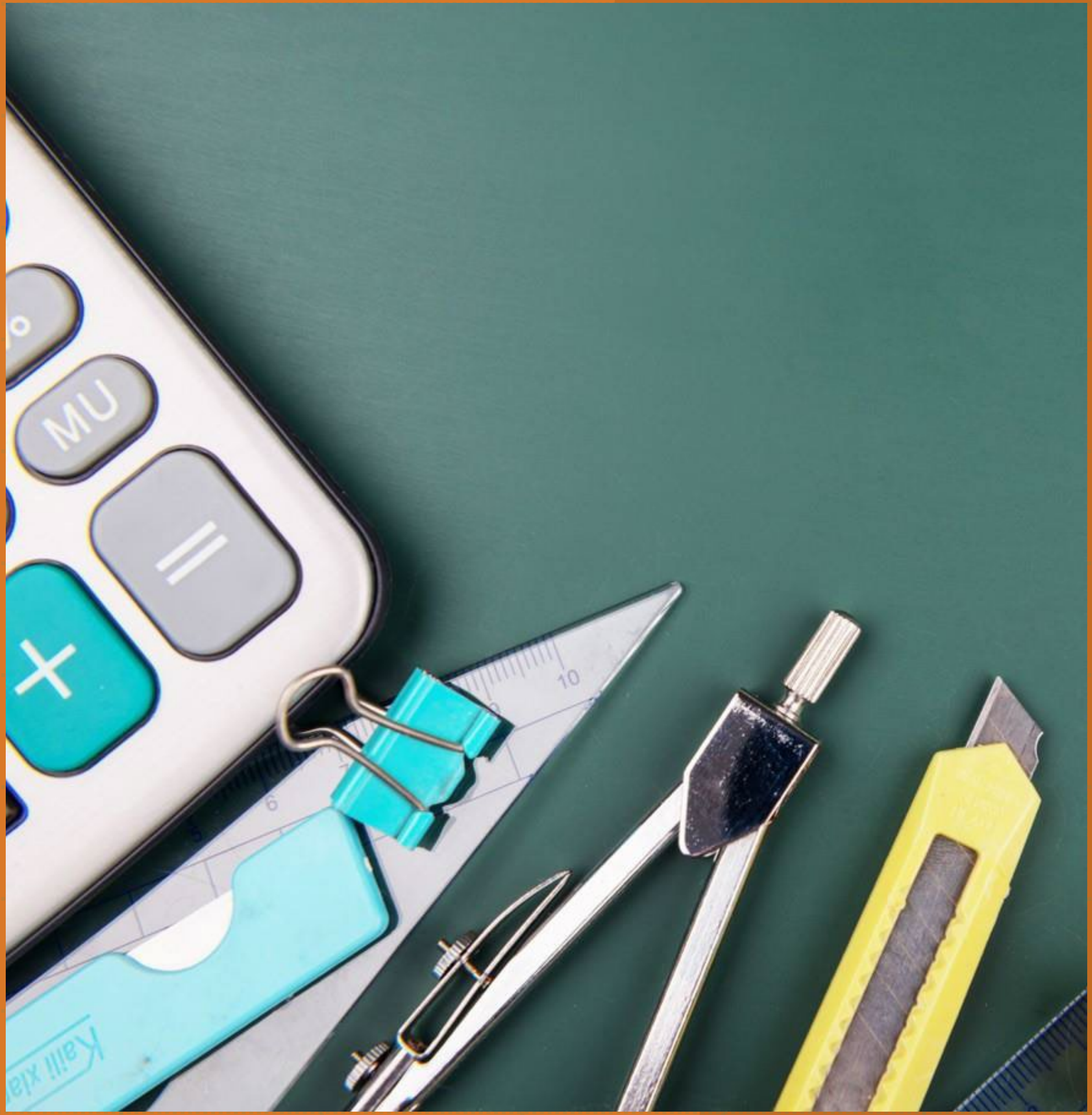
Key Points

Foundation of engineering education

Supports analytical thinking

Supports problem solving

Influences progression and retention



- Students enter with different preparation levels
- Mathematical misconceptions
- Learning difficulties
- Late identification of at-risk students

Challenges

Previous studies examined these factors separately. Our study integrates them into a single predictive framework

Research Area	Findings
Mathematics Achievement	Predicts engineering success
Learning Analytics	Supports intervention
Educational Data Mining	Predicts student performance
Misconceptions	Reduce achievement

Research Gap

Existing Studies

✓ Course performance
✓ Learning analytics
✓ Educational data mining

Missing

✗ Combined framework
✗ Misconception analysis
✗ Progression patterns
✗ AI prediction together

Research Objectives

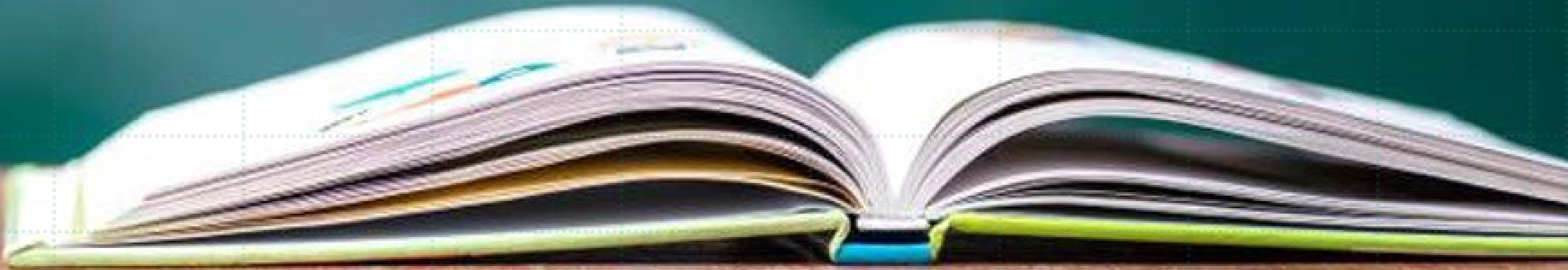
Study mathematics progression

Analyze misconceptions

Examine course relationships

Build AI prediction models

Identify at-risk students early



Data Sources

Student records (2019–2022)

Mathematics grades

Progression history

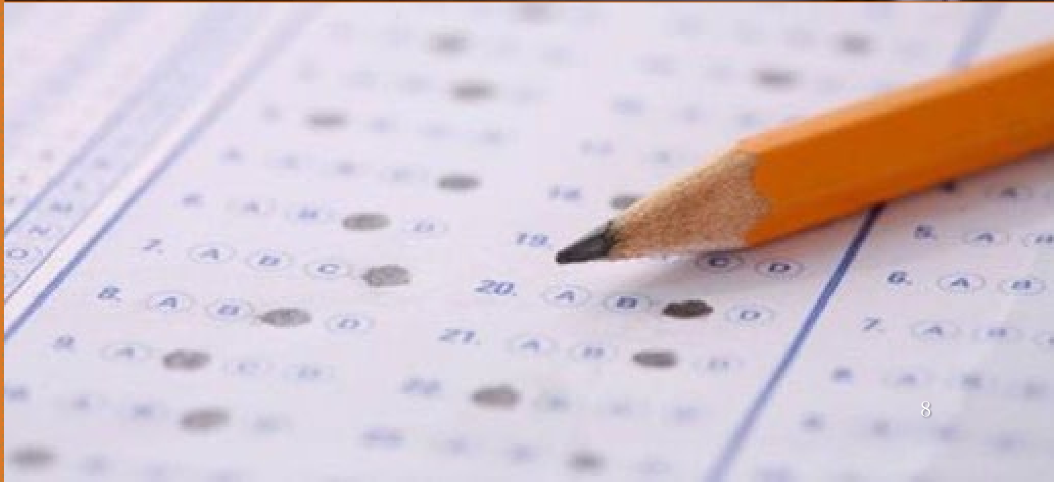
Misconception assessments

Features

Multiple mathematics levels

Male and female students

Historical academic performance



RESEARCH FRAMEWORK

AI-driven framework for predicting student success in engineering mathematics

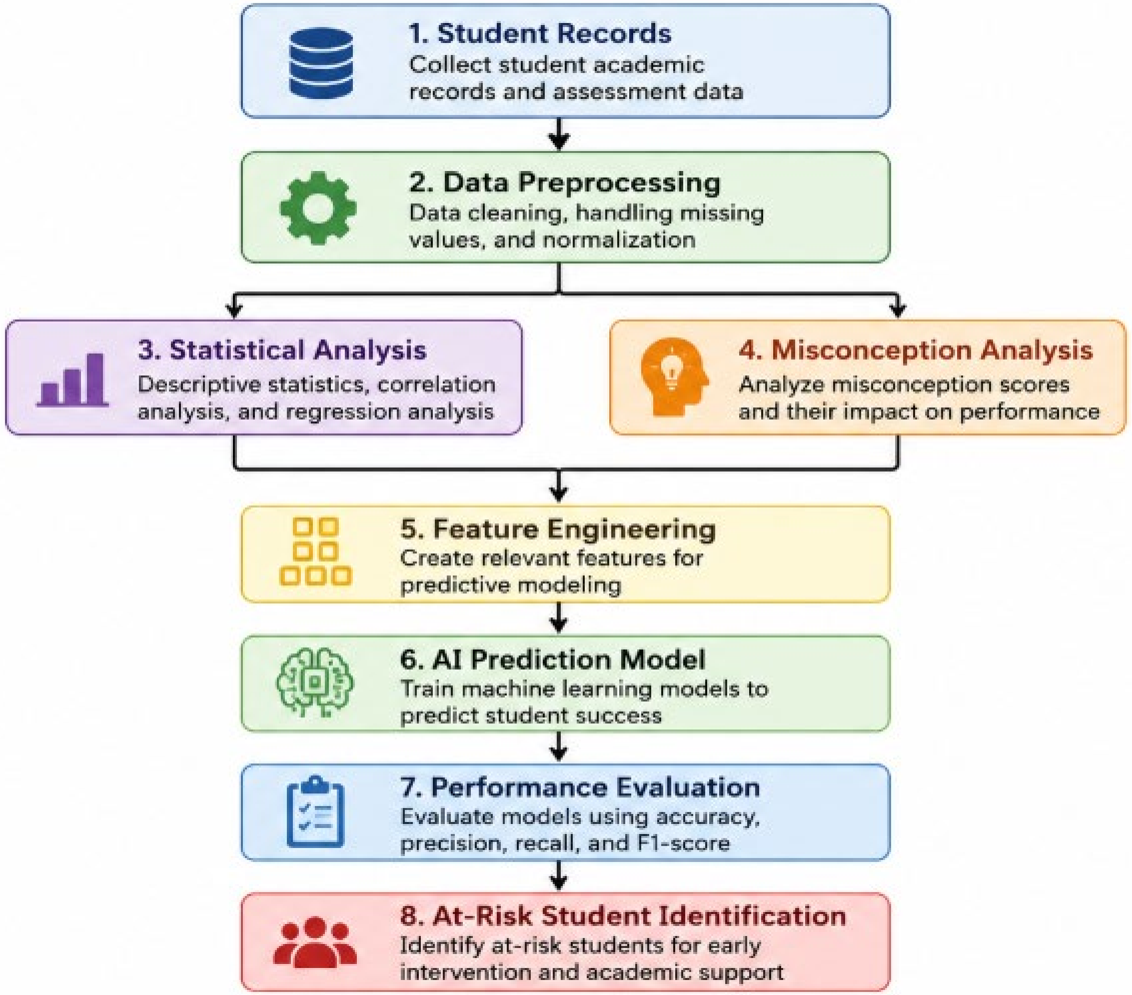


Figure 1. AI-driven framework for predicting student success in engineering mathematics using student records, statistical analysis, misconception analysis, feature engineering, machine learning, and risk prediction.

Statistical Analysis

Techniques Used

- Descriptive Statistics
- Correlation Analysis
- Regression Analysis
- Progression Tracking

Purpose

- Identify relationships among mathematics courses
- Examine progression patterns
- Investigate impact of misconceptions

AI Prediction Models

Machine Learning Models Evaluated

Random Forest

Gradient Boosting

XGBoost

Artificial Neural Networks

Input Features

Previous Mathematics Achievement

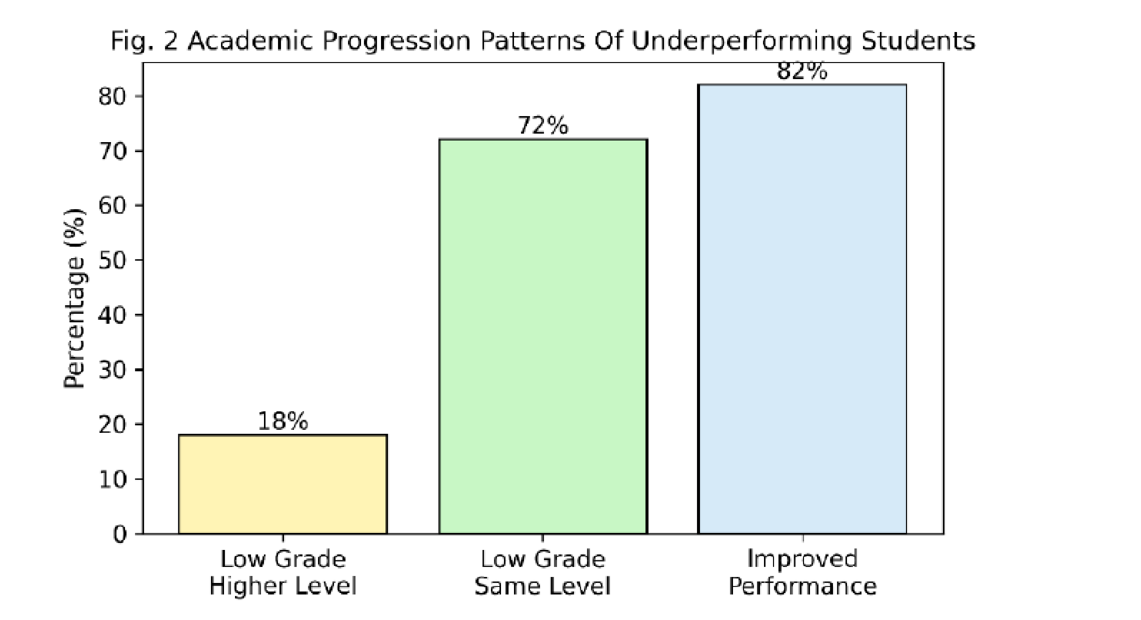
Progression History

Misconception Scores

Mathematics Level

Semester Indicator

Results: Academic Progression



Key Findings

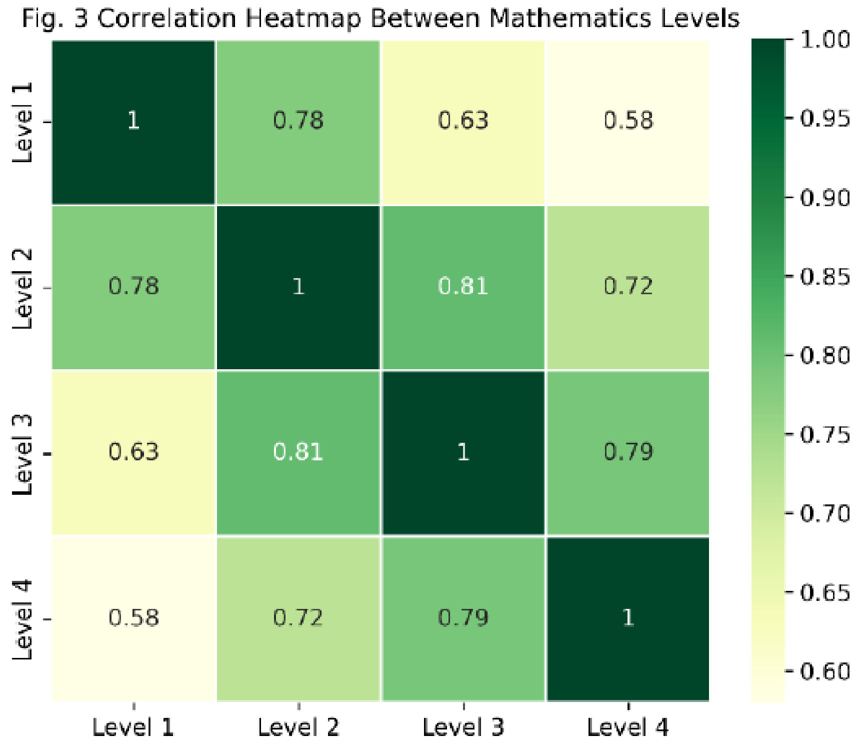
- Only 18% remained weak
- More than 80% improved later
- Early struggles do not guarantee future failure

Interpretation

Intervention works.

Students can recover and succeed.

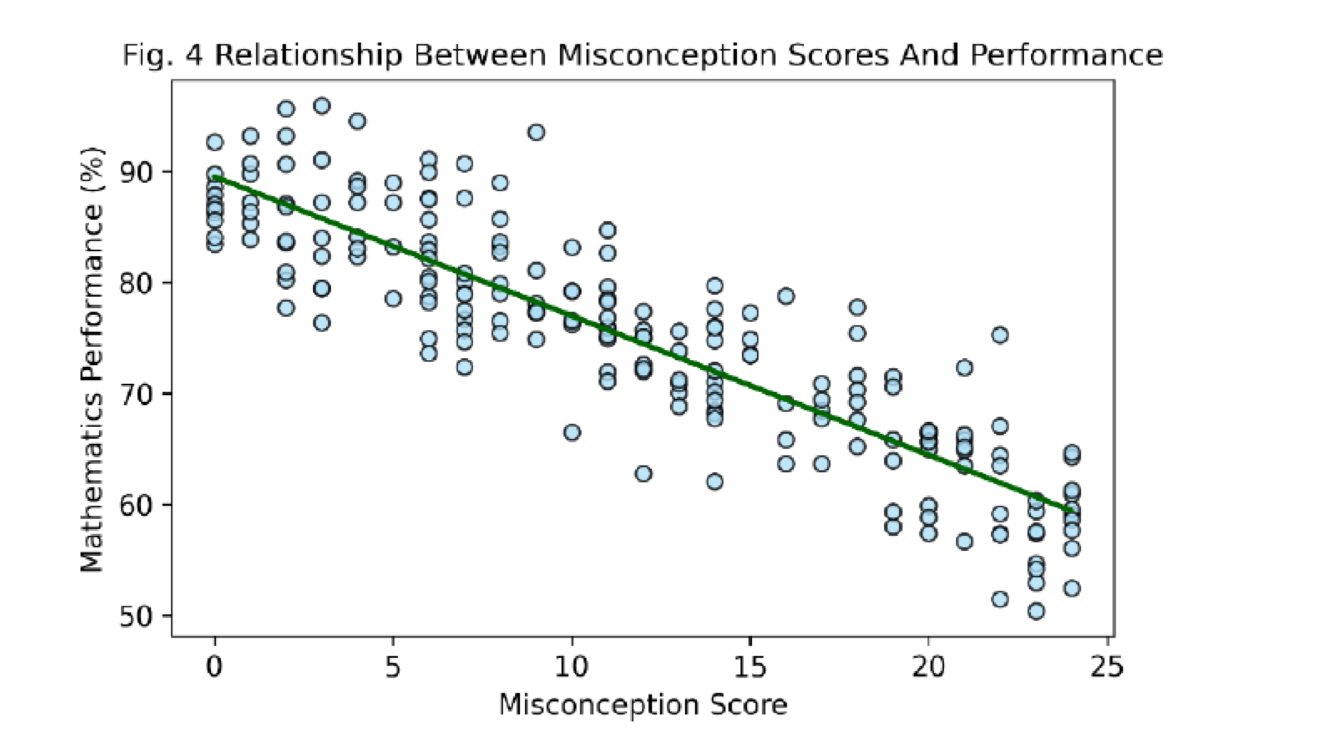
Fig. 3. Correlation Heatmap Between Mathematics Levels



Strong mathematical foundatio contribute significantly to futur success.

Relationship	Correlation
Level 2 – Level 3	0.81
Level 3 – Level 4	0.79
Level 1 – Level 2	0.78

Results: Misconception Analysis



Observation

Higher Misconceptions

⬇

Lower Mathematics Performance

Educational Meaning

- Misconceptions affect achievement
- Early diagnosis is important
- Remedial teaching can improve outcomes

Results: AI Model Performance

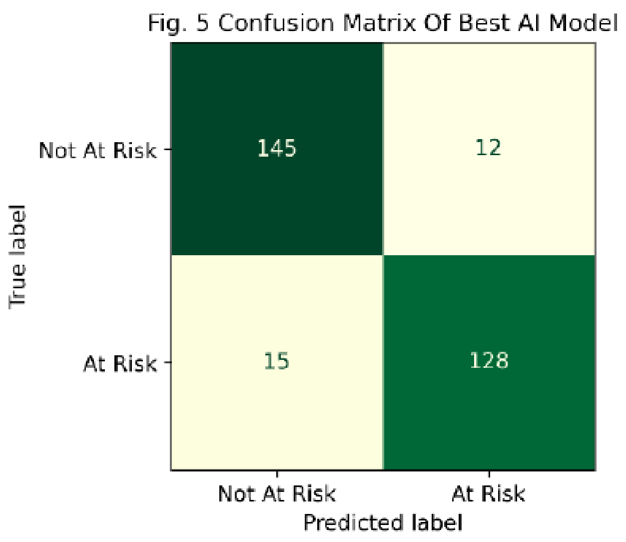


Fig. 5. Confusion Matrix of The Best AI Model

Best Performing Model
Random Forest
Performance

- Correctly classified most students
- Strong identification of at-risk learners
- Suitable for early warning systems

Feature Importance

Predictor	Importance
Previous Mathematics Achievement	42%
Academic Progression History	25%
Misconception Score	18%
Semester Indicator	9%
Mathematics Level	6%

Previous achievement remains the strongest predictor of future success.

Limitations

Single institution study

Limited number of academic years

Synthetic dataset used for AI model development

Limited demographic variables

Focused only on engineering mathematics

Future Directions

- Multi-institutional datasets
- Real-time learning analytics dashboards
- Integration with LMS systems
- Deep learning approaches
- Personalized intervention recommendations
- Explainable AI for educators

Conclusions

✓ Combined progression, misconceptions, and AI

✓ Strong relationship between mathematics levels

✓ Misconceptions significantly affect achievement

✓ Random Forest identified at-risk students effectively

✓ Practical framework for early intervention