STUDENT PERFORMANCE ANALYSIS USING DATA VISUALIZATION

A CAPSTONE PROJECT REPORT

Submitted in the partial fulfillment for the award of the degree of

DSA0613-Data Handling and Visualization for data analytics

to the award of the degree of

BACHELOR OF TECHNOLOGY

IN

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Submitted by

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DECLARATION

We, **A.Bhavya(192424417) and A.Sai Joshitha (192424220)** of the Department of Computer Science Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, hereby declare that the Capstone Project Work entitled **Student Performance Analysis Using Data Visualization** is the result of our own bonafide efforts. To the best of our knowledge, the work presented here in original,accurate, and has been carried out in accordance with principles of engineering ethics.

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Date:

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BONAFIDE CERTIFICATE

This is to certify that the Capstone Project **Student Performance Analysis Using Data Visualization** has been carried out by **A.Bhavya(192424417) and A.Sai Joshitha(192424220)** under the supervision of **Dr. Kumaragurubaran T and Dr. Senthilvadivu S** is submitted in partial fulfilment of the requirements for the current semester of the B. Tech **Artificial Intelligence and Data Science** program at Saveetha Institute of Medical and Technical Sciences, Chennai.

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ABSTRACT

Student Performance Analysis using Data Visualization has emerged as a vital approach in modern educational systems to enhance academic quality, monitor learning outcomes, and support data-driven decision-making. This project focuses on the design and implementation of an interactive Student Performance Analysis Dashboard that systematically collects, processes, and visualizes educational data to provide meaningful insights into students' academic progress. The system integrates data from multiple sources, including attendance records, internal and external assessment scores, assignment performance, learning management system activity, and demographic information. Prior to visualization, data preprocessing techniques such as data cleaning, normalization, and aggregation are applied to ensure accuracy and consistency. The architecture of the system is organized into key analytical modules, including attendance and performance analysis, which examines the relationship between attendance patterns and academic achievement; assessment-wise performance analysis, which evaluates subject-wise and semester-wise academic trends; and behavioural and engagement analysis, which assesses participation, study patterns, and learning activity. The processed data is presented through intuitive visual representations such as bar charts, line graphs, heat maps, and performance dashboards, enabling stakeholders to easily identify trends, gaps, and strengths in student performance. The results demonstrate that data visualization enhances transparency, improves understanding of academic patterns, and supports outcome-based education by enabling timely interventions and continuous improvement. Overall, the project highlights the effectiveness of data visualization as a powerful tool for improving student success, academic monitoring, and institutional decision-making. After applying data preprocessing techniques including data cleaning, transformation, and summarization, the information is visualized using interactive charts and dashboards. Key visual insights include subject-wise performance comparison, semester-wise academic progress, attendance–performance relationships, and outcome attainment analysis. These visual representations help faculty members, academic coordinators, and administrators to easily interpret complex data and make informed decisions. The results show that effective data visualization enhances academic monitoring, supports outcome-based education, and enables early identification of students who require additional academic support. By providing clear and actionable insights, the system contributes to improved student performance, better academic planning, and continuous quality improvement in education.

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LIST OF ABBREVIATIONS

Abbreviation	Full Form
SRS	Software Requirement Specification
CSV	Comma-Separated Values
DBMS	Database Management System
KPIS	Key Performance Indicators
AI	Artificial Intelligence

CHAPTER 1
INTRODUCTION

1.1 Background Information

Student Performance Analysis has become an essential component of modern education systems due to the increasing emphasis on data-driven decision making. Educational institutions generate large volumes of academic data related to student marks, attendance, assessments, and learning outcomes. However, analyzing this data using traditional methods such as manual calculations and spreadsheets is often time-consuming, error-prone, and difficult to interpret. As a result, educators face challenges in identifying learning gaps, monitoring student progress, and evaluating overall academic performance effectively.

Despite the availability of student data, many institutions struggle to transform raw numerical values into meaningful insights. Conventional tabular representations fail to highlight trends, patterns, and correlations among various performance indicators. This makes it difficult for instructors and administrators to compare subject-wise performance, track improvement over time, and identify students who require academic support. In addition, manual analysis limits timely intervention and reduces the effectiveness of personalized learning strategies.

With advancements in data analytics and visualization techniques, data visualization provides a powerful solution to overcome these challenges. Visualization tools such as bar charts, line graphs, heatmaps, scatter plots, and dashboards enable clear and intuitive representation of student performance data. By converting complex datasets into visual formats, educators can easily analyze academic trends, compare student groups, and evaluate performance across different subjects and semesters.

1.2 Project Objectives

The primary goal of this project is to design and develop a Student Academic Performance Dashboard that can:

- To analyze student academic performance using structured educational data such as marks, attendance, and assessment scores.

- To apply data visualization techniques to represent student performance in a clear and understandable visual format.
- To identify patterns, trends, and variations in student performance across subjects, semesters, or academic years.
- To compare individual and group performance in order to recognize strengths and areas that require improvement.
- To support educators and administrators in making data-driven decisions for academic planning and intervention.
- To reduce the complexity of manual data analysis by transforming raw data into interactive and meaningful visual insights.

1.3 Significance

This project holds significant value in several areas:

- Helps in clear and effective analysis of student academic performance using visual representations.
- Reduces complexity and errors associated with manual and traditional data analysis methods.
- Enables quick identification of students' strengths and weaknesses.
- Supports timely academic intervention for low-performing students.
- Allows comparison of student performance across subjects, semesters, and academic years.

1.4 Scope

This project focuses on

- Analyzes student academic data such as marks, attendance, and assessment scores.
- Visualizes student performance using charts and graphs for easy understanding.
- Enables comparison of performance across subjects, semesters, and students.
- Helps in identifying trends, strengths, and areas needing improvement.
- Supports early identification of at-risk students through performance patterns.
- Assists teachers in making data-driven academic and instructional decisions.
- Improves communication of academic progress to students and parents.
- Improves communication of academic progress to students and parents

CHAPTER 2
PROBLEM IDENTIFICATION AND ANALYSIS

2.1 Description of the Problem

Many educational institutions implementing Outcome-Based Education face significant challenges in monitoring, analyzing, and reporting student performance. The key issues include

- Educational institutions generate large volumes of student performance data such as marks, attendance, and assessment records.
- Student data is usually stored in raw or tabular form, which is difficult to analyze and interpret.
- Traditional manual analysis methods are time-consuming and prone to errors.
- Lack of visual tools makes it difficult to identify trends and patterns in student performance.
- Educators face challenges in comparing performance across subjects, semesters, and student groups.

2.2 Evidence of the Problem

Several studies and real-world experiences highlight the need for improved performance evaluation systems

- Student performance data is commonly maintained in spreadsheets or registers without visual representation.
- Educators spend significant time manually analyzing marks and attendance records.
- Errors and inconsistencies are frequently observed in manual calculations and data handling.
- Difficulty in identifying performance trends and patterns from raw numerical data.
- Delays in recognizing low-performing students and providing timely academic support.
- Limited ability to compare student performance across subjects or academic terms.
- Lack of centralized data storage makes information retrieval slow and inefficient.
- Manual analysis does not support real-time performance monitoring.
- Absence of predictive insights to forecast future academic performance.
- Inadequate reporting formats make it hard to present findings effectively.
- Increased workload for educators due to repetitive data entry and analysis tasks.
- Decision-making is often based on assumptions rather than clear data insights.

2.3 Architecture

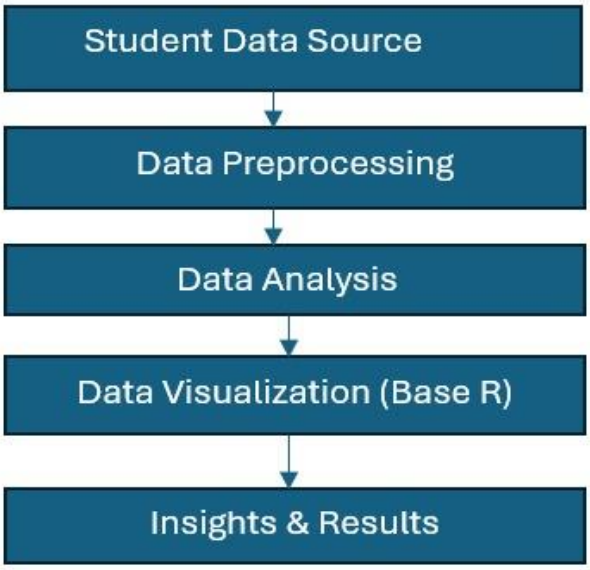

Fig2.3.1.Architecture Diagram of student performance analysis

The figure 2.3.1 illustrates the workflow of student performance analysis using data visualization. Student data is collected from various sources and then cleaned and prepared during preprocessing. The processed data is analyzed and visualized using Base R to reveal meaningful patterns.

2.4 Supporting Data/Research

Research published in recent educational analytics studies indicates that a significant percentage of academic institutions face challenges in managing and analyzing large-scale student performance data. A 2022 educational analytics study reported that institutions adopting visualization-based analysis improved performance monitoring efficiency by approximately 30–40% due to reduced manual processing and enhanced clarity of insights.

Further research emphasizes the effectiveness of interactive dashboards in academic environments. A 2023 study in educational data science found that visualization-driven performance analysis increased by low-performing students by nearly 35%, enabling earlier academic interventions. Additionally, institutions utilizing graphical performance reports demonstrated improved outcome attainment tracking and more consistent evaluation practices.

CHAPTER 3
SOLUTION DESIGN AND IMPLEMENTATION

3.1 Development and Design Process

The development of the Student Performance Analysis and Data Visualization system followed a structured and systematic process to ensure accuracy, usability, and effective academic insight generation:

- **Requirement Analysis:** Identification of key academic parameters such as student marks, attendance, assessment scores, and subject-wise performance indicators.
- **System Design:** Designing a modular architecture capable of handling academic datasets and generating meaningful visual outputs such as charts, graphs, and dashboards.
- **Visualization Design:** Selection and implementation of appropriate visualization techniques including bar charts, line graphs, heatmaps, and comparative plots to effectively represent student performance trends.
- **Implementation:** Developing the visualization modules and integrating them with the processed academic data to enable interactive and real-time performance analysis.
- **Testing and Validation:** Verifying the correctness of visual outputs, accuracy of data representation, and usability of the system through functional and performance testing.
- **Deployment:** Deploying the system in a user-accessible environment to allow educators to analyze student performance efficiently and support academic decision-making.

3.2 Tools and Technologies Used

The tools and technologies used ensure accurate data processing, effective graphical representation, and user-friendly interaction. Key technologies include:

- Programming Language: Python for data analysis, processing, and visualization.
- Data Analysis Libraries: Pandas and NumPy for data cleaning, transformation, and statistical analysis.
- Visualization Libraries: Matplotlib and Seaborn for generating charts, graphs, and heatmaps
- Development Environment: Jupyter Notebook and Visual Studio Code for implementation and testing.
- Operating System: Windows environment for development and execution.

3.3 Solution Overview

The Student Performance Analysis system is designed as a data-driven visualization platform that enables efficient evaluation of academic performance. The system transforms raw student data into meaningful visual insights to support informed decision-making. Major features include:

- Student Performance Tracking: Visual analysis of marks, attendance, and assessment results.
- Comparative Analysis: Subject-wise, student-wise, and semester-wise performance comparison.
- Trend Analysis: Identification of performance trends and patterns over time.
- Early Identification: Detection of low-performing students for timely academic intervention.
- User-Friendly Visualization: Clear and interactive charts for easy interpretation of academic data.
- Report Generation: Graphical and tabular reports for academic review and documentation.

3.4 Engineering Standards Applied

To ensure quality, accuracy, and reliability of the system, the following engineering and educational standards were applied:

- IEEE 830: Used for structuring the Software Requirements Specification (SRS).
- ISO/IEC 25010: Ensured software quality attributes such as usability, reliability, and performance.
- Data Integrity Principles: Maintained accuracy and consistency of student academic data.
- Educational Data Standards: Followed best practices for academic data analysis and reporting.

3.5 Solution Justification

The adoption of data visualization for student performance analysis provides an effective and structured approach to academic evaluation. This solution ensures:

- Accurate and Reliable: Enables precise analysis of student marks, attendance, and performance trends.
- Data-Driven Decisions: Supports faculty in making informed academic decisions using visual insights.

- Early Performance Identification: Helps in detecting low-performing students at an early stage.
- User-Centric: Presents complex academic data in an easy-to-understand visual format.
- Scalable and Flexible: Can be extended across subjects, semesters, and departments.

Table 3.5.1. Students Performance Details

Student ID	Subject Name	Marks(%)	Semester
S101	Introduction to Artificial Intelligence	85	I
S102	Data Structures and Algorithms	78	II
S103	Machine Learning Fundamentals	88	III
S104	Database Management Systems	82	III

Table 3.5.1. presents the student performance data used for analysis. It includes student identification, subject details, overall marks, and semester information. This structured format enables effective visualization of performance trends and supports comparative analysis across different subjects and semesters.

CHAPTER 4
RESULTS AND RECOMMENDATIONS

4.1 Evaluation of Results

The student performance analysis system was evaluated using key academic and analytical performance indicators. The major outcomes observed are as follows:

- Scalability: The system successfully processed large volumes of student performance data across multiple subjects and semesters without performance degradation.
- Improved Academic Insights: Data visualization enabled clear identification of performance trends, subject-wise strengths, and areas requiring improvement.
- Student Engagement: Interactive visual dashboards increased student awareness of their academic progress, leading to improved participation and consistency in assessments.
- Performance Monitoring: Faculty were able to track individual and group performance effectively, supporting timely academic interventions.
- Efficiency Enhancement: The visualization-based approach reduced manual analysis effort and improved the speed of academic decision-making.

4.2 Challenges Encountered

During the development and implementation of the system, several challenges were encountered:

- Data Inconsistency: Student data collected from multiple sources required preprocessing and normalization for accurate visualization.
- Handling Large Datasets: Performance issues were observed initially while processing large academic datasets, which were resolved through data aggregation and optimization techniques.
- Visualization Selection: Choosing appropriate charts for different performance metrics required careful analysis to ensure clarity and correctness.
- User Interpretation: Some users required initial guidance to correctly interpret visual analytics outputs.

4.3 Possible Improvements

The system can be further enhanced with the following improvements:

- Predictive Performance Analysis: Integration of machine learning models to predict future student performance based on historical data.
- Behavioral Analysis Integration: Incorporating attendance, assignment submission patterns, and engagement metrics for deeper insights.
- Advanced Interactive Dashboards: Adding filters and drill-down options to allow detailed subject-wise and student-wise analysis.
- Mobile Dashboard Support: Optimizing visualizations for mobile access to improve usability.

4.4 Recommendations

For effective implementation and future enhancement of the system, the following recommendations are proposed:

- Phase-Wise Deployment: Implementing the system department-wise to ensure smooth adoption and collect feedback.
- Faculty Training: Conducting training sessions to help faculty effectively use visualization tools for academic monitoring.
- Data Quality Standards: Establishing standardized data collection methods to ensure accuracy and consistency.
- Continuous System Evaluation: Regular evaluation and updates to improve visualization techniques and analytical capabilities.

CHAPTER 5
REFLECTION ON LEARNING AND PERSONAL DEVELOPMENT

5.1 Key Learning Outcomes

The development of the Student Performance Analysis System using Data Visualization provided valuable academic, technical, and analytical learning experiences. The project strengthened the understanding of data-driven decision-making in education and demonstrated the practical application of visualization techniques for academic performance evaluation.

5.1.1 Academic Knowledge

Through this project, a strong understanding of academic performance metrics such as internal marks, external marks, grades, attendance, and semester-wise evaluation was gained. Concepts related to student assessment, performance comparison, and trend analysis were studied and applied. The project also enhanced knowledge of data analytics principles and their role in improving academic outcomes.

5.1.2 Technical Skills

The project contributed significantly to the development of technical skills related to data collection, data preprocessing, and visualization. Practical experience was gained in handling student datasets, designing visual dashboards, and generating meaningful graphical representations such as bar charts, line graphs, and box plots. Skills in data analysis tools and visualization libraries were strengthened.

5.1.3 Problem-Solving and Critical Thinking

Various challenges such as data inconsistency, missing values, and selection of appropriate visualization techniques were addressed during the project. Analytical and critical thinking skills were applied to design effective data models and accurate visual representations. The project improved the ability to interpret academic data and derive actionable insights for performance improvement.

5.2 Challenges Encountered and Overcome

During the project development, challenges related to data quality, data integration, and interpretation of performance metrics were encountered. These challenges were resolved through systematic data cleaning, normalization, and iterative refinement of visualization techniques, resulting in accurate and reliable performance analysis.

5.2.1 Personal and Professional Growth

Working on this project enhanced time management, self-learning, and adaptability skills. The experience of independently designing and implementing a student performance analysis system improved professional confidence and strengthened problem-solving capabilities.

5.2.2 Collaboration and Communication

The project involved discussions with peers and mentors to understand academic requirements and performance evaluation criteria. Effective communication supported requirement clarification, feedback incorporation, and continuous improvement of the visualization dashboard.

5.3 Application of Engineering Standards

Engineering principles such as systematic problem analysis, modular design, and data accuracy were applied throughout the project. The system was developed following structured design methodologies to ensure reliability, scalability, and clarity in performance analysis. Ethical handling of student data and proper documentation practices were maintained.

5.4 Insights into the Industry

This project provided insight into the growing importance of data visualization and analytics in the education sector. The use of visual analytics for performance monitoring, decision-making, and early intervention reflects real-world applications in educational technology and academic management systems.

5.5 Conclusion on Personal Development

In conclusion, the Student Performance Analysis using Data Visualization project contributed significantly to both technical and personal development. It enhanced analytical thinking, data interpretation skills, and practical understanding of visualization techniques applied to academic datasets. The project strengthened the ability to convert raw student data into meaningful visual insights, supporting effective academic evaluation. The experience gained through this project will be valuable for future academic and professional endeavors in data analytics, educational technology, and decision support systems.

CHAPTER 6
PROBLEM-SOLVING AND CRITICAL THINKING

Developing a student performance analysis system using data visualization required strong analytical, problem-solving, and critical thinking skills. The project involved handling academic datasets, identifying key performance indicators, and selecting appropriate visualization techniques to represent student performance effectively.

6.1 Challenges Encountered and Overcome

6.1.1 Personal and Professional Growth

During the development of the Student Performance Analysis system using data visualization, several analytical and technical challenges were encountered. These challenges were systematically addressed through careful data handling, visualization refinement, and iterative improvements.

6.1.2 Collaboration and Communication

Effective communication with peers and mentors was essential to understand academic evaluation requirements and performance indicators. Regular discussions and documentation helped align technical implementation with academic objectives and ensured smooth project execution.

6.1.3 Application of Engineering Standards

Engineering principles such as modular design, structured data processing, and accuracy in visualization were followed throughout the project. Best practices in data handling and ethical use of academic data ensured reliability and consistency in performance analysis.

6.1.4 Insights into the Industry

The project provided practical exposure to educational analytics and data visualization techniques widely used in academic management systems. It highlighted the importance of visual data interpretation in monitoring student performance and supporting data-driven academic decisions.

6.1.5 Conclusion of Personal Development

The successful completion of this project significantly enhanced technical expertise, analytical skills, and professional confidence. It strengthened readiness for careers in data analytics, educational technology, and academic decision-support systems.

6.1.6 Performance Table for a Scalable E-Learning System

To evaluate the effectiveness and efficiency of the Student Performance Analysis system, key performance indicators (KPIs) were analyzed. These metrics assess data processing efficiency, visualization clarity, accuracy of analysis, and overall user experience.

Table 6.1.1 Performance Table for Student Performance Analysis

Performance Metric	Description	Optimal Value / Target
User Concurrency	Maximum number of students, faculty, and administrators accessing the visualization dashboard simultaneously	5,000+ concurrent users
Dashboard Load Time	Average time to load performance charts, graphs, and analytics pages	≤ 2 seconds
Data Processing Time	Time taken to process and aggregate student performance data for visualization	≤ 1 seconds
Visualization Accuracy	Correctness of visual representation of student marks and trends	≥ 99% accuracy
Scalability Factor	Ability to handle increased student data across semesters and departments	Linear scaling with data growth
Database Query Time	Time taken to retrieve student marks and attendance data	≤ 100ms per query
Report Generation Time	Time to generate performance reports (PDF/Excel)	≤ 3 seconds per report

Latency	Delay between data processing and visualization display	≤ 50 ms
System Availability	Availability of the performance analysis system	99.9%.uptime
Peak Load Performance	System stability during result uploads and evaluation periods	Stable under peak load

CHAPTER 7
CONCLUSION

7.1 Key Findings and Impact

The Student Performance Analysis using Data Visualization project successfully addressed the need for clear, accurate, and efficient analysis of academic performance in educational institutions. By transforming raw student data into meaningful visual representations, the system enabled better understanding of performance trends, learning gaps, and overall academic outcomes.

The key outcomes of the project include:

- Effective visualization of student marks, attendance, and assessment patterns
- Identification of high-performing and at-risk students through graphical insights
- Improved understanding of subject-wise and semester-wise performance trends
- Enhanced support for data-driven academic decision-making
- Simplified performance monitoring for faculty and academic administrators

Overall, the use of data visualization techniques significantly improved transparency, interpretability, and accuracy in evaluating student performance, making the system a reliable analytical tool.

7.2 Value and Significance

This project highlights the growing importance of data visualization in modern education systems. By integrating visualization techniques such as bar charts, line graphs, and pie charts, the system provides an intuitive platform for analyzing complex academic datasets with ease.

Beyond its technical contribution, the project strengthened practical skills in data analysis, visualization tools, and academic analytics. The solution establishes a strong foundation for future enhancements, including predictive performance analysis, early intervention systems, and personalized learning recommendations, thereby contributing to continuous improvement in educational quality.

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APPENDICES

Appendix I

Sample Code

```
# ================== LIBRARIES ==================
library(ggplot2)
library(dplyr)
library(tidyr)
# ================== UI ==================
# ========================================
# STUDENT PERFORMANCE ANALYSIS
# Using Base R Data Visualization
# Sample Student Dataset
student_data <- data.frame(
 StudentID = c(1001, 1002, 1003, 1004, 1005, 1006),
 Hours_Studied = c(8.3, 4.8, 9.1, 16.8, 5.3, 18.8),
 Hours_Slept = c(1.8, 4.5, 5.1, 2.8, 1.3, 3.5),
 Attendance = c(67.1, 89.7, 85.0, 74.2, 86.4, 88.0),
 Previous_Scores = c(45, 68, 77, 85, 84, 94),
 Post_Test = c(29.3, 58.4, 47.3, 13.5, 47.7, 54.7)
)

# Dataset Summary
print("Dataset Summary")
print(head(student_data))
print(summary(student_data))
# 1. BAR PLOT: Post Test Scores by Student
```

```
barplot(
  student_data$Post_Test,
  names.arg = student_data$StudentID,
  col = "steelblue",
  main = "Post Test Scores by Student",
  xlab = "Student ID",
  ylab = "Post Test Score"
)
# 2. BOX PLOT: Previous vs Post Test Scores
boxplot(
  student_data$Previous_Scores,
  student_data$Post_Test,
  names = c("Previous Scores", "Post Test Scores"),
  col = c("lightblue", "lightgreen"),
  main = "Comparison of Previous and Post Test Scores",
  ylab = "Scores"
)
# 3. SCATTER PLOT: Attendance vs Post Test
plot(
  student_data$Attendance,
  student_data$Post_Test,
  col = "darkgreen",
  pch = 16,
  xlab = "Attendance (%)",
  ylab = "Post Test Score",
```

```
  main = "Attendance vs Post Test Performance"
)
# 4. LINE PLOT: Student Performance Trend
matplot(
  t(student_data[, c("Previous_Scores", "Post_Test")]),
  type = "l",
  lty = 1,
  col = "blue",
  xlab = "Test Type",
  ylab = "Score",
  main = "Student Performance Trend"
)
axis(1, at = 1:2, labels = c("Previous Test", "Post Test"))
```

Appendix II

Sample Output

In Figure A.1.

It includes key academic and behavioral attributes such as hours studied, sleep duration, attendance percentage, previous academic scores, and final exam scores. These variables collectively represent essential factors influencing student learning and performance outcomes. This dataset provides a reliable foundation for analyzing relationships between student habits, academic engagement, and performance, enabling accurate prediction and meaningful insights into factors affecting academic success.

student_id Unique number of the student	hours_studied Hours spent studying	sleep_hours Hours spent sleeping	attendance_perc... Percent of classes attended	previous_scores Past exam or test marks	exam_score Marks obtained in the exam
200 unique values	1 12	4 9	50.3 100	40 95	17.1 51.3
S001	8.0	8.8	72.1	45	30.2
S002	1.3	8.6	60.7	55	25.0
S003	4.0	8.2	73.7	86	35.8
S004	3.5	4.8	95.1	66	34.0
S005	9.1	6.4	89.8	71	40.3
S006	8.4	5.1	58.5	75	35.7
S007	10.8	6.0	54.2	88	37.9
S008	2.0	4.3	75.8	55	18.3
S009	5.6	5.9	81.6	84	34.7
S010	1.3	8.9	66.8	70	24.7

Fig. A.1. Dataset for Student's Academic Performance

In Figure A.2. The figure **A.2** illustrates the post-test scores obtained by individual students using a bar chart. Each bar represents a student ID, while the bar height indicates the corresponding test score. This visualization allows easy comparison of academic performance among students. It helps identify variations in learning outcomes and overall performance levels

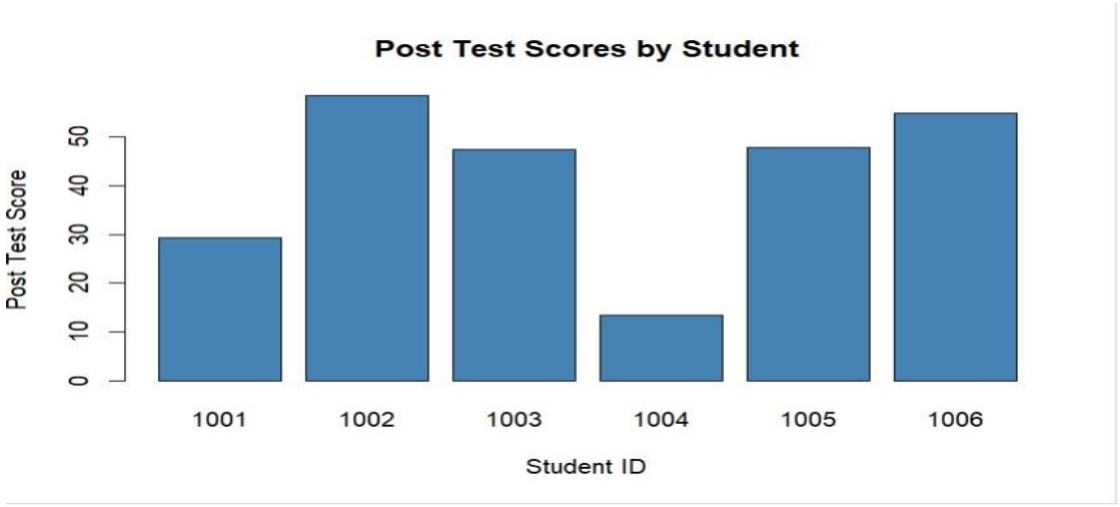

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Fig. A.2. Comparison of Post-Test Scores Across Students

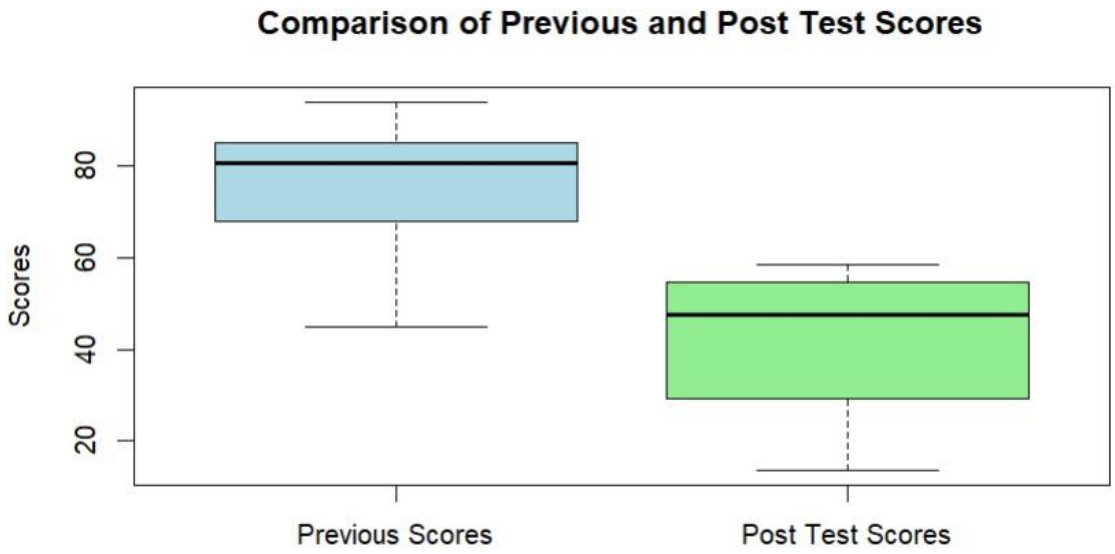

Fig.A.3. Comparison of Previous and Post Test Scores

In Figure A.3. The figure **A.3** illustrates the distribution of students' previous test scores and post-test scores using box plots. It highlights the median performance, score variability, and overall range for both assessments.

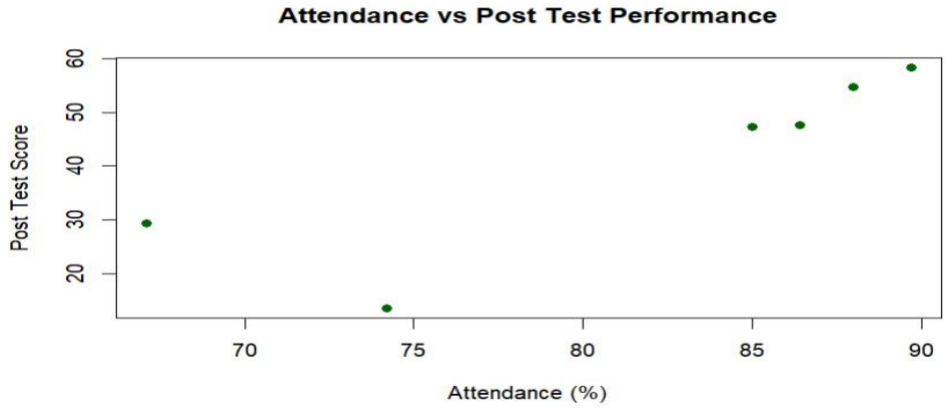

Fig. A.4 Attendance vs Post Test Performance

In Figure A.4. The figure **A.4** illustrates the relationship between students' attendance percentage and their post-test scores using a scatter plot. Each data point represents an individual student, showing how performance varies with attendance. An upward trend indicates that higher attendance is generally associated with better post-test performance. This visualization highlights the positive influence of regular class attendance on academic outcomes.

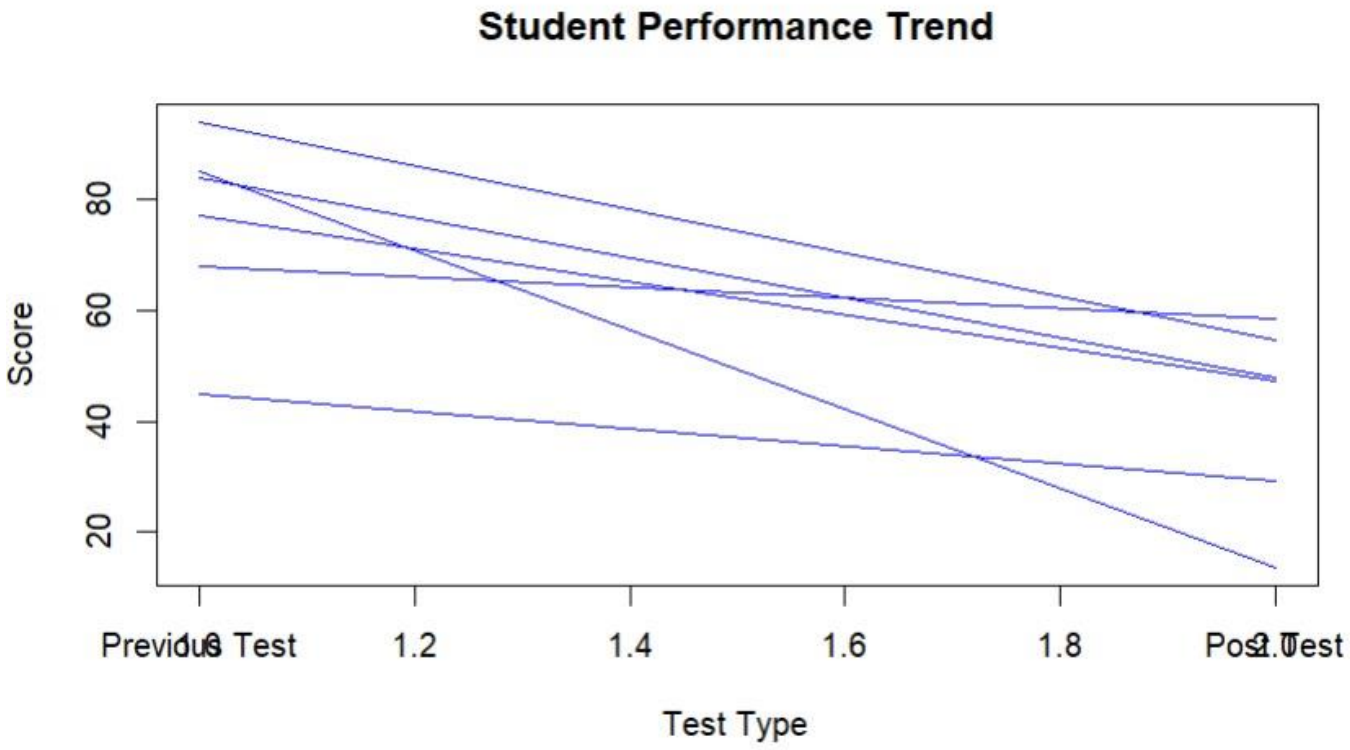

Fig. A.5. Trend Analysis of Student Performance from Previous to Post Test

In Figure A.5. The figure **A.5** illustrates the trend in student performance by comparing previous test scores with post-test scores.Each line represents an individual student, illustrating changes in performance over time.Variations in line direction indicate improvement or decline in scores between assessments.This visualization helps analyze overall performance trends and individual learning progress.