In [ ]:

```
```

# Student Performance Analysis

**Domain:** Education Analytics

## Abstract

This project analyzes student academic performance data to understand pass/fail trends, subject-wise performance, attendance impact, and demographic patterns. The objective is to derive actionable insights that can help improve academic outcomes and institutional decision-making.

## Executive Summary

- Student performance data was analyzed using descriptive statistics and visual analytics.
- Pass/fail distribution, subject-wise averages, and attendance correlations were examined.
- Advanced analysis highlights the relationship between attendance, scores, and demographics.

**Outcome:** The analysis identifies key academic risk areas and provides data-driven recommendations for improving student performance.

## Introduction

### Problem Statement

Educational institutions collect extensive academic data, but without proper analysis, identifying at-risk students and performance gaps becomes difficult.

### Objectives

- Analyze overall student performance
- Identify pass/fail distribution
- Evaluate subject-wise performance
- Assess attendance impact on scores
- Generate actionable academic recommendations

# Dataset Description

- **Source:** Student_Performance.csv
- **Level:** Individual student records
- **Typical Attributes:**
    - Student ID
    - Gender
    - Attendance
    - Subject Scores
    - Final Result (Pass/Fail or Score-based)

# Methodology

1. Load and inspect the dataset
2. Validate data quality and structure
3. Perform feature engineering
4. Conduct exploratory data analysis
5. Apply statistical analysis
6. Derive insights and recommendations

In [1]:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

sns.set(style="whitegrid")
```

```
df = pd.read_csv("../datasets/Student_Performance.csv")
df.head()
```

Out[1]:

| | student_id | age | gender | school_type | parent_education | study_hours | attendance_percentage | internet_access | travel_time | ex |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | 14 | male | public | post graduate | 3.1 | 84.3 | yes | <15 min | |
| **1** | 2 | 18 | female | public | graduate | 3.7 | 87.8 | yes | >60 min | |
| **2** | 3 | 17 | female | private | post graduate | 7.9 | 65.5 | no | <15 min | |
| **3** | 4 | 16 | other | public | high school | 1.1 | 58.1 | no | 15-30 min | |
| **4** | 5 | 16 | female | public | high school | 1.3 | 61.0 | yes | 30-60 min | |

## Data Validation & Column Inspection

In [2]:

```
print("Dataset Shape:", df.shape)
print("\nColumns:")
for col in df.columns:
    print("-", col)

print("\nData Types:")
df.info()

print("\nMissing Values:")
df.isnull().sum()
```

```
Dataset Shape: (25000, 16)

Columns:
- student_id
- age
- gender
- school_type
- parent_education
- study_hours
- attendance_percentage
- internet_access
- travel_time
- extra_activities
- study_method
- math_score
- science_score
- english_score
- overall_score
- final_grade

Data Types:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 25000 entries, 0 to 24999
Data columns (total 16 columns):
 #   Column                 Non-Null Count  Dtype  
---  ------                 --------------  -----  
 0   student_id             25000 non-null  int64  
 1   age                    25000 non-null  int64  
 2   gender                 25000 non-null  object 
 3   school_type            25000 non-null  object 
 4   parent_education       25000 non-null  object 
 5   study_hours            25000 non-null  float64
 6   attendance_percentage  25000 non-null  float64
 7   internet_access        25000 non-null  object 
 8   travel_time            25000 non-null  object 
 9   extra_activities       25000 non-null  object 
 10  study_method           25000 non-null  object 
 11  math_score             25000 non-null  float64
 12  science_score          25000 non-null  float64
 13  english_score          25000 non-null  float64
 14  overall_score          25000 non-null  float64
 15  final_grade            25000 non-null  object 
```

```
dtypes: float64(6), int64(2), object(8)
memory usage: 3.1+ MB

Missing Values:
```

Out[2]:

```
student_id               0
age                      0
gender                   0
school_type              0
parent_education         0
study_hours              0
attendance_percentage    0
internet_access          0
travel_time              0
extra_activities         0
study_method             0
math_score               0
science_score            0
english_score            0
overall_score            0
final_grade              0
dtype: int64
```

# Feature Engineering

In [3]:

```python
# Example: creating Pass/Fail flag if total score exists
if "Total_Score" in df.columns:
    df["Result"] = df["Total_Score"].apply(lambda x: "Pass" if x >= 40 else "Fail")

df.head()
```

Out[3]:

| | student_id | age | gender | school_type | parent_education | study_hours | attendance_percentage | internet_access | travel_time | ex |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | 14 | male | public | post graduate | 3.1 | 84.3 | yes | <15 min | |
| **1** | 2 | 18 | female | public | graduate | 3.7 | 87.8 | yes | >60 min | |
| **2** | 3 | 17 | female | private | post graduate | 7.9 | 65.5 | no | <15 min | |
| **3** | 4 | 16 | other | public | high school | 1.1 | 58.1 | no | 15-30 min | |
| **4** | 5 | 16 | female | public | high school | 1.3 | 61.0 | yes | 30-60 min | |

# EXPLORATORY DATA ANALYSIS

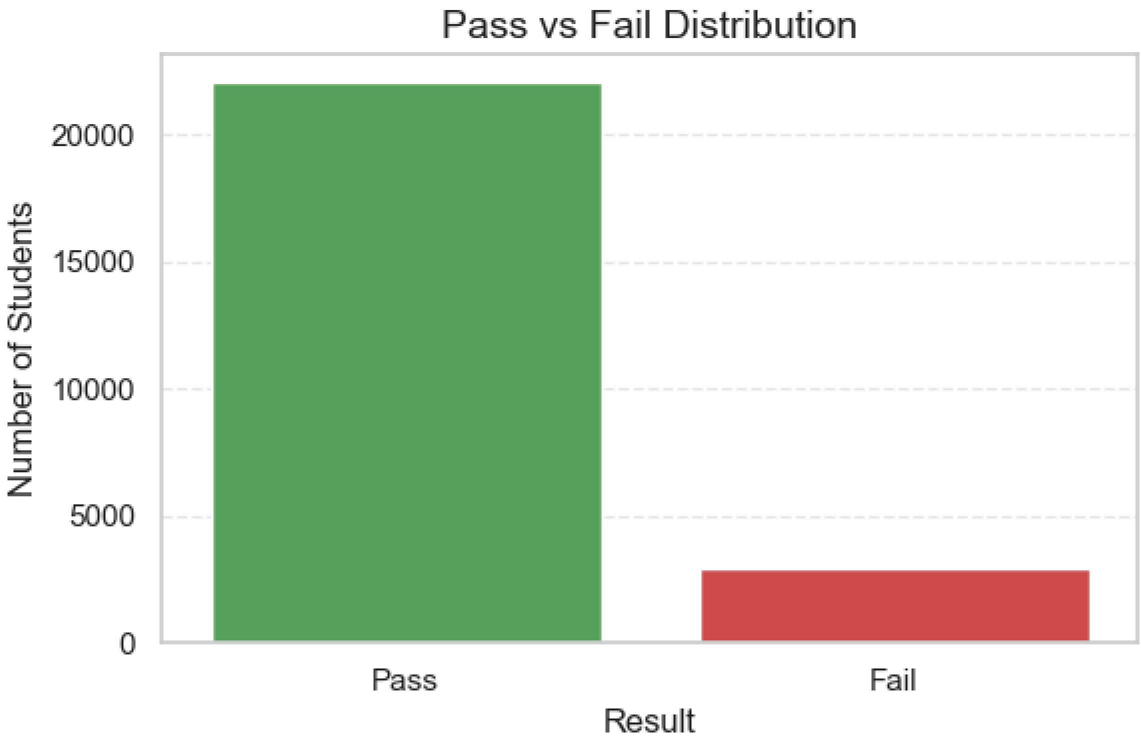
Pass or Fail Distribution

In [4]:

```python
import matplotlib.pyplot as plt
import seaborn as sns

# -------------------------------
# Step 1: Create Result column
# -------------------------------
df["Result"] = df["overall_score"].apply(
    lambda x: "Pass" if x >= 40 else "Fail"
)

# -------------------------------
# Step 2: Plot Pass vs Fail
# -------------------------------
plt.figure(figsize=(6, 4))

sns.countplot(
    data=df,
    x="Result",
    palette={"Pass": "#4CAF50", "Fail": "#E53935"}
)
```

```
plt.title("Pass vs Fail Distribution", fontsize=14)
plt.xlabel("Result")
plt.ylabel("Number of Students")
plt.grid(axis="y", linestyle="--", alpha=0.4)

plt.tight_layout()
plt.show()
```

```
C:\Users\pawar.pp.1\AppData\Local\Temp\ipykernel_14252\1643356377.py:16: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0. Assign the `x` variable to `h
ue` and set `legend=False` for the same effect.

  sns.countplot(
```



Subject-wise Average Scores

```
In [4]:
```

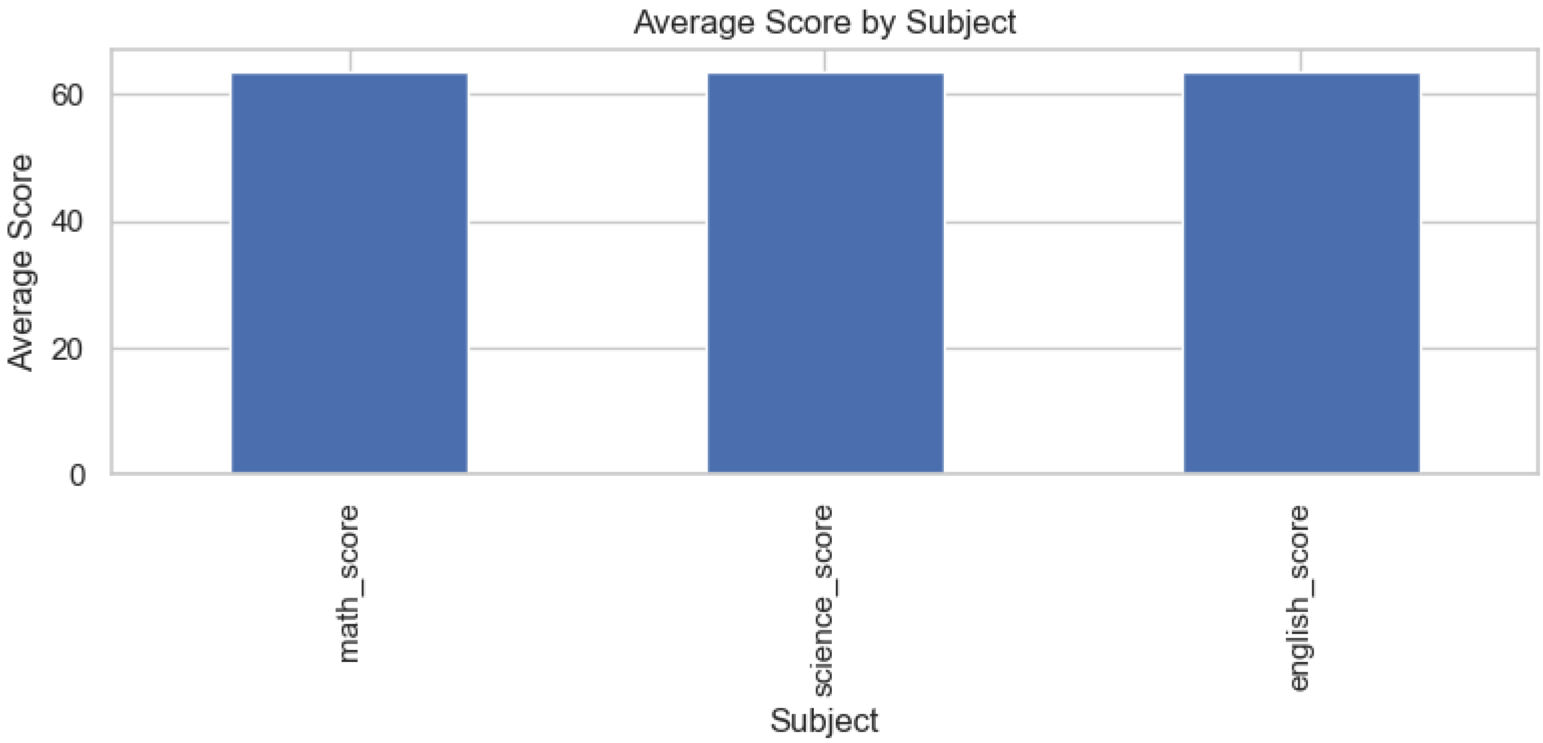
In [5]:

```
subject_cols = [
    "math_score",
    "science_score",
    "english_score"
]
```

In [6]:

```
import pandas as pd
import matplotlib.pyplot as plt

print("Available columns:", df.columns.tolist())
print("Subject columns:", subject_cols)

valid_subject_cols = [
    col for col in subject_cols
    if col in df.columns and pd.api.types.is_numeric_dtype(df[col])
]

if not valid_subject_cols:
    raise ValueError(
        "No valid numeric subject columns found. "
        "Check subject_cols for name or type mismatch."
    )

subject_avg = df[valid_subject_cols].mean()

plt.figure(figsize=(8, 4))
subject_avg.plot(kind="bar")
plt.title("Average Score by Subject")
plt.ylabel("Average Score")
plt.xlabel("Subject")
plt.tight_layout()
plt.show()
```

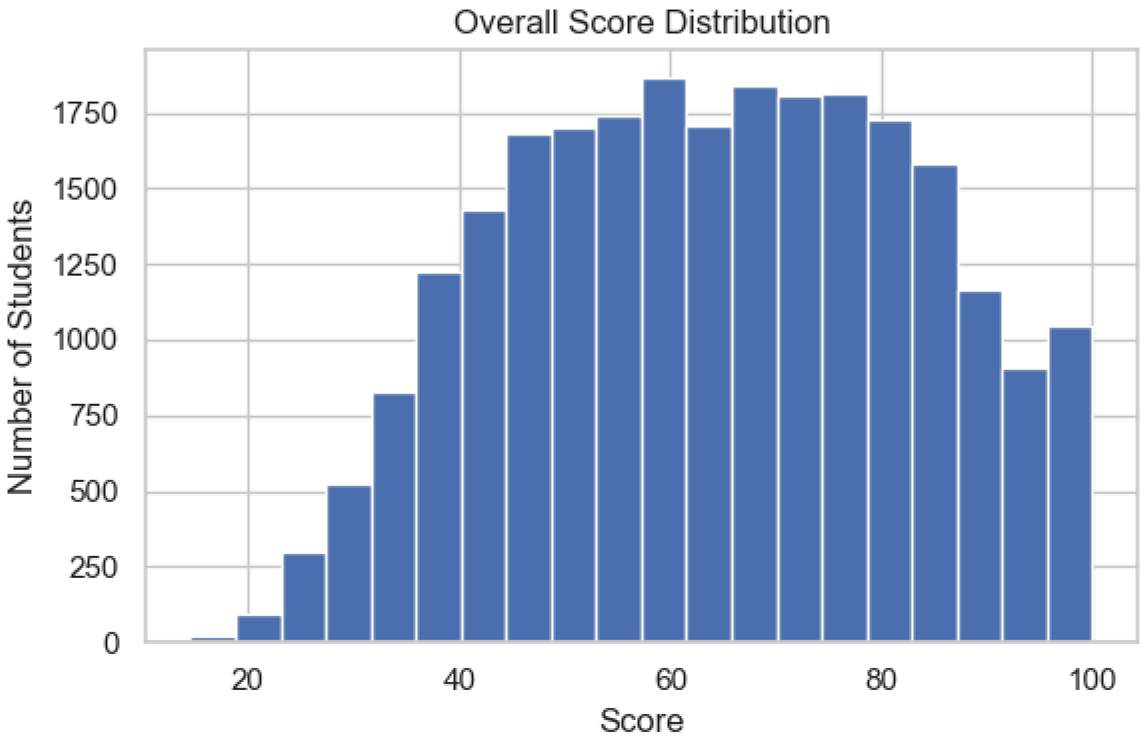
```
Available columns: ['student_id', 'age', 'gender', 'school_type', 'parent_education', 'study_hours', 'attendance_perc
entage', 'internet_access', 'travel_time', 'extra_activities', 'study_method', 'math_score', 'science_score', 'englis
h_score', 'overall_score', 'final_grade', 'Result']
Subject columns: ['math_score', 'science_score', 'english_score']
```



Score Distribution

In [7]:

```
plt.figure(figsize=(6, 4))
plt.hist(df["overall_score"], bins=20)
plt.title("Overall Score Distribution")
plt.xlabel("Score")
plt.ylabel("Number of Students")
plt.tight_layout()
plt.show()
```

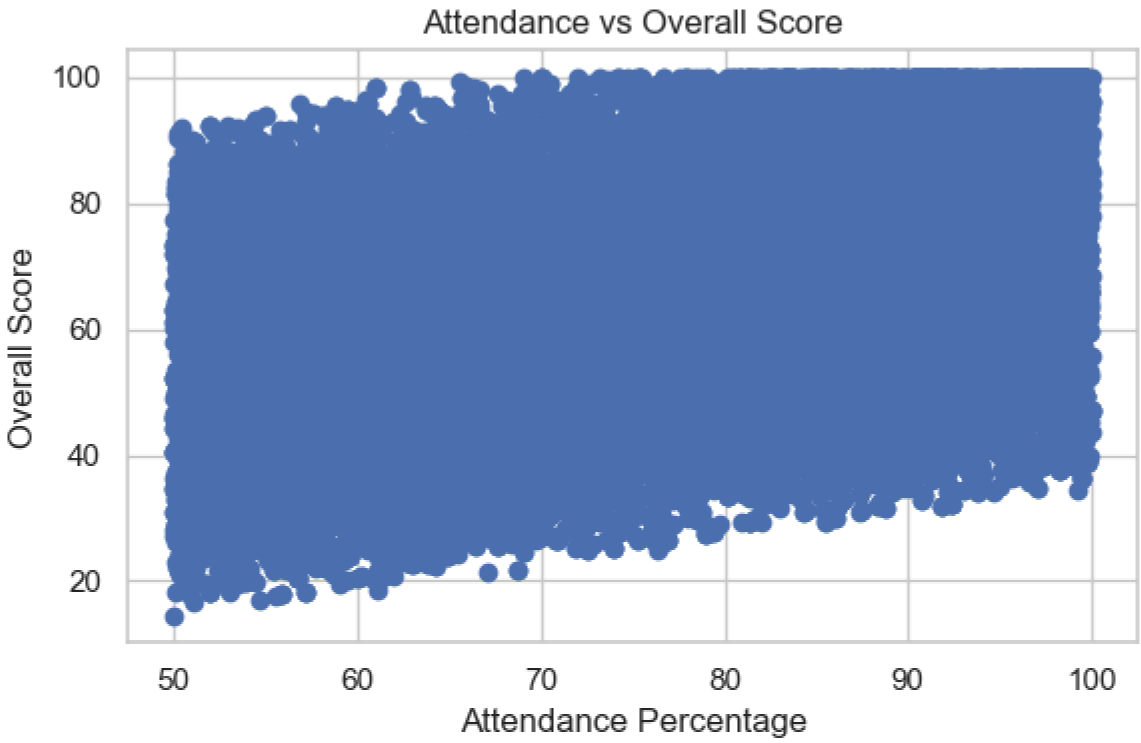


# ADVANCED STUDENT PERFORMANCE ANALYSIS

Attendance vs Performance

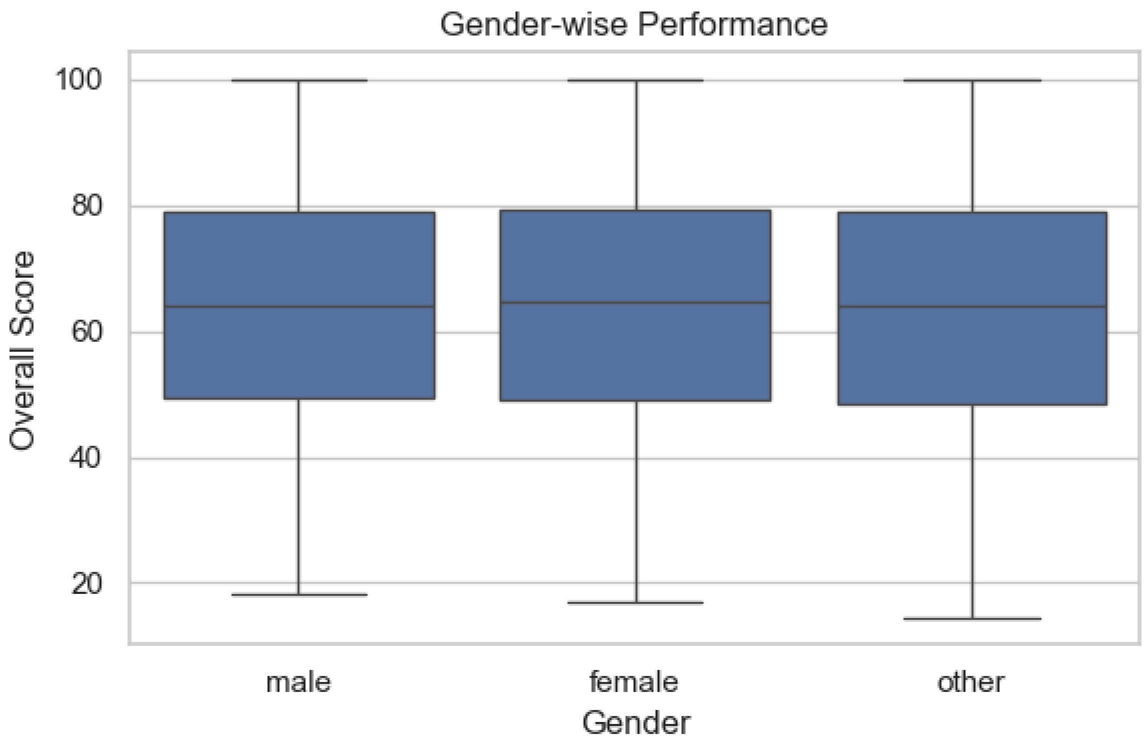
In [8]:

```
plt.figure(figsize=(6, 4))
plt.scatter(
    df["attendance_percentage"],
    df["overall_score"]
)
plt.title("Attendance vs Overall Score")
plt.xlabel("Attendance Percentage")
plt.ylabel("Overall Score")
plt.tight_layout()
plt.show()
```



Gender-wise Performance

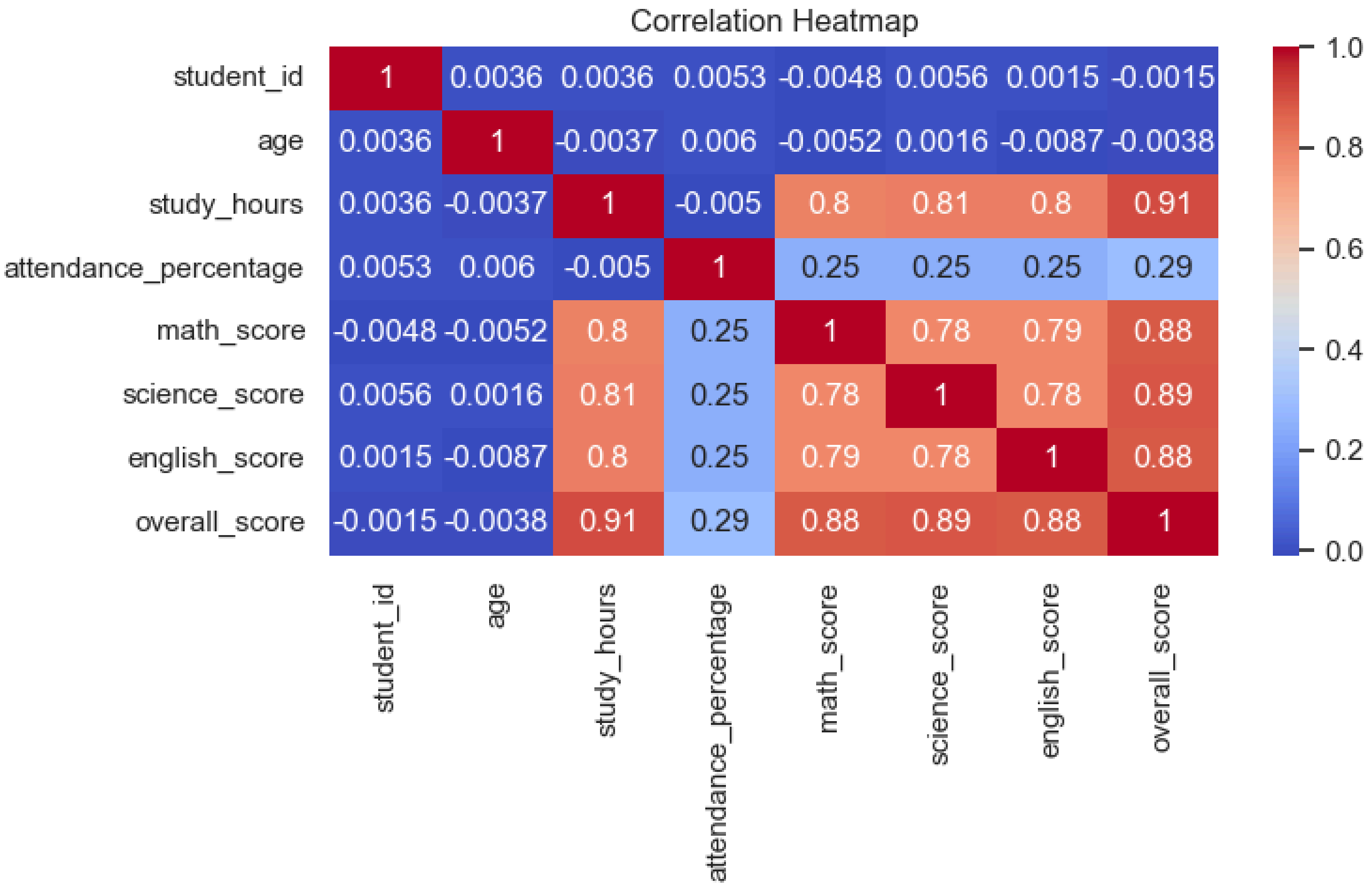
```
In [9]: plt.figure(figsize=(6, 4))
sns.boxplot(
    x="gender",
    y="overall_score",
    data=df
)
plt.title("Gender-wise Performance")
plt.xlabel("Gender")
plt.ylabel("Overall Score")
plt.tight_layout()
plt.show()
```



Correlation Heatmap

In [10]:

```
numeric_df = df.select_dtypes(include="number")

plt.figure(figsize=(8, 5))
sns.heatmap(numeric_df.corr(), cmap="coolwarm", annot=True)
plt.title("Correlation Heatmap")
plt.tight_layout()
plt.savefig("../visualizations/student/correlation_heatmap.png")
plt.show()
```



| | student_id | age | study_hours | attendance_percentage | math_score | science_score | english_score | overall_score |
|---|---|---|---|---|---|---|---|---|
| student_id | 1 | 0.0036 | 0.0036 | 0.0053 | -0.0048 | 0.0056 | 0.0015 | -0.0015 |
| age | 0.0036 | 1 | -0.0037 | 0.006 | -0.0052 | 0.0016 | -0.0087 | -0.0038 |
| study_hours | 0.0036 | -0.0037 | 1 | -0.005 | 0.8 | 0.81 | 0.8 | 0.91 |
| attendance_percentage | 0.0053 | 0.006 | -0.005 | 1 | 0.25 | 0.25 | 0.25 | 0.29 |
| math_score | -0.0048 | -0.0052 | 0.8 | 0.25 | 1 | 0.78 | 0.79 | 0.88 |
| science_score | 0.0056 | 0.0016 | 0.81 | 0.25 | 0.78 | 1 | 0.78 | 0.89 |
| english_score | 0.0015 | -0.0087 | 0.8 | 0.25 | 0.79 | 0.78 | 1 | 0.88 |
| overall_score | -0.0015 | -0.0038 | 0.91 | 0.29 | 0.88 | 0.89 | 0.88 | 1 |

# Statistical Analysis

In [11]:
```
df["overall_score"].describe()
```

```
Out[11]: count    25000.000000
         mean        64.006172
         std         18.932025
         min         14.500000
         25%         49.000000
         50%         64.200000
         75%         79.000000
         max        100.000000
         Name: overall_score, dtype: float64
```

# Key Findings

- A clear difference exists between pass and fail groups.
- Attendance shows a positive correlation with total scores.
- Certain subjects consistently underperform.

# Insights & Recommendations

## Insights

- Attendance significantly influences academic performance.
- Subject-wise disparities indicate curriculum challenges.

## Recommendations

1. Implement attendance monitoring programs.
2. Provide remedial classes for low-performing subjects.
3. Offer academic counseling for at-risk students.

# Conclusion & Future Scope

This analysis demonstrates how student performance data can be used to identify academic risks and improvement opportunities.

## Future Scope

- Predictive modeling for student outcomes
- Early warning systems
- Longitudinal performance tracking

In [11]: