Cornwallis Academy
Ambitions for All

SMILE
SUCCESSFUL | MOTIVATED | INSPIRED | LEARNING | EXCITED & ENGAGED

Year 13 Mathematical Studies

Critical Analysis

Learning Objectives

- To understand what is meant by critical analysis and to analyse the clarity of statements focusing on the use of language.
- To analyse the clarity of statements based on figures which must have calculations to back them up
- To critically analyse statements focusing on various assumptions and understand what assumptions are acceptable.
- To understand how the selectivity and sampling methods can obscure results
- To analyse graphs to see how they might be misleading.
- To understand the links between two events: Causation or coincidence?
- To critically analyse a mathematical model.

What previous knowledge is required?

Knowledge built upon from GCSE:

- Calculating index numbers
- Interpreting graphs

How will this term's content help with future learning?

Studying this unit helps learners to:

- Interpret information presented in reports, graphs, and statistics.
- Assess the reliability of data sources.
- Identify bias and misleading presentations of data.
- Evaluate the assumptions behind mathematical arguments.
- Judge whether conclusions are supported by evidence.
- Develop logical reasoning and communication skills.

These skills support future learning in subjects such as:

- Economics
- Psychology
- Sociology
- Business Studies
- Geography
- Politics

The unit is particularly valuable in higher education, where students are expected to evaluate evidence, challenge assumptions, and justify conclusions.

Common Misconceptions

1. "If statistics are presented, the conclusion must be true."
Misconception: Numbers automatically make an argument reliable.
Correction: Statistics can be misinterpreted, selectively chosen, or presented in a misleading way. The source and methodology should always be examined.

2. "Correlation means causation."
Misconception: If two variables are related, one must cause the other.
Correction: A relationship between variables does not prove that one causes the other. Other factors may be involved.

3. "Large samples are always reliable."
Misconception: A large sample guarantees accurate conclusions.
Correction: Reliability depends on how the sample was selected as well as its size. A large biased sample can still be misleading.

4. "Graphs always present information fairly."
Misconception: Graphical representations are objective.
Correction: Choices of scale, axis range, and presentation style can exaggerate or hide patterns in data.

5. "Average values describe everyone in a group."
Misconception: The mean or median represents all individuals equally.
Correction: Measures of spread and variation must also be considered because individuals may differ greatly from the average.

National Curriculum / Specification

AQA Specification reference:
C1.1 , C2.1, C3.1 , C3.2

The normal distribution

Learning Objectives

- An introduction to the Normal distribution and its key features
- To calculate intervals and probabilities from the standard normal distribution.
- To calculate more complex intervals and probabilities
- To standardise values
- To calculate probabilities from a normal distribution.
- To calculate more complex intervals and probabilities.

What previous knowledge is required?

Knowledge built upon from GCSE:

- Calculating the mean
- Working with percentages
- Working with total probability
- Drawing and interpreting histograms
- Understanding probability
- Calculating mean
- Using a calculator
- Interpreting graphs

How will this term's content help with future learning?

Studying this unit helps learners to:

- Understand how data is distributed around an average.
- Interpret probabilities and likelihoods.
- Analyse variation within datasets.
- Use statistical models to make predictions.
- Interpret standard deviation and measures of spread.
- Evaluate whether data follows an expected pattern.

These skills support future learning in subjects such as:

- Psychology
- Biology
- Economics
- Geography
- Business Studies
- Engineering

The unit also provides a foundation for further statistical study at A-level, university, and in careers involving data analysis and research.

Common Misconceptions

1. "All data follows a normal distribution."
Misconception: Every dataset forms a bell-shaped curve.
Correction: Many datasets do not follow a normal distribution. Some may be skewed, have multiple peaks, or contain unusual patterns.

2. "The mean, median and mode are always different."
Misconception: Measures of average must have different values.
Correction: In a perfectly normal distribution, the mean, median, and mode are all equal and located at the centre of the distribution.

3. "Most values are spread evenly across the distribution."
Misconception: Values occur with equal frequency throughout the curve.
Correction: Values near the mean occur much more frequently than values far from the mean.

4. "Standard deviation measures the average."
Misconception: Standard deviation is another type of average.
Correction: Standard deviation measures how spread out the data is around the mean, not the centre of the data.

5. "A larger standard deviation means a higher average."
Misconception: More spread means a greater mean value.
Correction: Standard deviation and mean measure different characteristics of a dataset. A distribution can have a large spread but a low mean, or vice versa.

6. "Values outside one standard deviation are unusual."
Misconception: Data beyond one standard deviation from the mean is rare.
Correction: In a normal distribution, approximately 68% of values lie within one standard deviation, meaning about 32% lie outside it.

7. "Probability and frequency are the same thing."
Misconception: Probability always equals the number of times an event occurs.
Correction: Probability describes the likelihood of an event, while frequency describes how often it actually occurs in observed data.

National Curriculum / Specification

AQA Specification reference:
S1.1, S 2.1 , S3.1

Confidence Intervals

Learning Objectives

- To understand what is meant by quality control and why it is needed.
- To understand what the sample mean is.
- To calculate the standard error.
- To calculate the distribution of a sample.
- An introduction to confidence intervals and what they mean.
- To calculate the common confidence intervals.
- To be able to use the tables to calculate different confidence intervals.
- To calculate confidence intervals.

What previous knowledge is required?

Knowledge built upon from previous chapters)

- Understanding the shape of the normal distribution
- Using tables to find probabilities from any normal distribution
- Calculating the mean and standard deviation

How will this term's content help with future learning?

Studying this unit helps learners to:

- Understand the difference between a sample and a population.
- Interpret estimates and their accuracy.
- Evaluate the reliability of survey results and research findings.
- Understand margins of error.
- Compare statistical estimates critically.
- Make informed decisions based on incomplete information.

These skills support future learning in subjects such as:

- Psychology
- Sociology
- Economics
- Biology
- Geography
- Business Studies

The unit is particularly useful when interpreting opinion polls, scientific studies, market research, and reports that use statistical evidence to support conclusions.

Common Misconceptions

1. "A confidence interval contains all possible values."
Misconception: Any value outside the interval is impossible.
Correction: Values outside the interval are still possible; they are simply considered less consistent with the sample evidence.

2. "A 95% confidence interval means there is a 95% chance the true value is inside it."
Misconception: The interval itself has a 95% probability of containing the true value.
Correction: The confidence level refers to the method. If many samples were taken and intervals calculated in the same way, about 95% of those intervals would contain the true population value.

3. "A larger sample always guarantees a correct result."
Misconception: Increasing sample size ensures accuracy.
Correction: Larger samples generally produce more precise estimates, but poor sampling methods can still lead to biased results.

4. "Narrow confidence intervals mean the estimate is correct."
Misconception: A small interval proves the estimate is accurate.
Correction: A narrow interval indicates greater precision, but systematic errors or bias may still affect accuracy.

5. "Overlapping confidence intervals mean there is no difference."
Misconception: Two estimates with overlapping intervals must be identical.
Correction: Overlap suggests caution when claiming a difference, but it does not automatically prove that no difference exists.

6. "Confidence intervals eliminate uncertainty."
Misconception: Once an interval is calculated, uncertainty disappears.
Correction: Confidence intervals are designed to express uncertainty, not remove it.

7. "The sample result and population value must be the same."

Misconception: A sample estimate should exactly match the true population value.
Correction: Sampling variation means different samples often produce slightly different estimates.

National Curriculum / Specification

AQA Specification reference
S4.1 , S4.2
S5.1,
S6.1

Correlation and regression

Learning Objectives

- Plotting scatter graphs.
- Understanding the different types of correlation and comment on them including reference to strength.
- Understand the features of a line of best fit and plot one.
- To use lines of best fit to make predictions.
- Straight line graphs, link to y-mx+c.
- To calculate equation of regression on the calculator.
- Plotting more complex lines of regression.
- Using regression lines to make predictions and interpreting regression lines.
- To calculate Pearson's product moment correlation coefficient and understand what it means.
- Understand the difference between correlation and causation.
- Consolidation and exam question practice.

What previous knowledge is required?

Knowledge from GCSE and prior learning on this course

- Plotting points
- Interpreting graphs
- Thinking skills
- Plotting a scatter graph
- Recognising types of correlation
- Identifying outliers
- Using scatter diagrams
- Drawing lines of best fit
- The equation of a straight line
- Calculating the mean
- Substituting into equations

How will this term's content help with future learning?

Studying this unit helps learners to:

- Identify and interpret relationships between variables.
- Recognise positive, negative, and zero correlation.
- Use regression models to estimate and predict values.
- Analyse trends in data.
- Evaluate the strength of relationships.
- Make evidence-based decisions using statistical information.

These skills support future learning in subjects such as:

- Economics
- Psychology
- Geography
- Biology
- Business Studies

- Engineering

The unit is particularly useful for interpreting research studies, market trends, scientific investigations, and any situation where data is used to understand patterns or make forecasts.

Common Misconceptions

1. "Correlation means causation."
Misconception: If two variables are correlated, one must cause the other.
Correction: Correlation only indicates an association between variables. Other factors may explain the relationship.
Example: Ice cream sales and sunburn cases both increase during summer, but ice cream does not cause sunburn.

2. "A strong correlation proves a relationship is important."
Misconception: A high correlation coefficient automatically means the relationship is meaningful.
Correction: Statistical relationships should be considered alongside context, data quality, and possible external influences.

3. "A correlation of zero means the variables are unrelated."
Misconception: No correlation means there is no relationship at all.
Correction: Variables may have a non-linear relationship that is not detected by simple correlation measures.

4. "Regression predictions are exact."
Misconception: Values predicted by a regression model will always occur.
Correction: Regression provides estimates based on trends in the data and is subject to uncertainty.

5. "Regression can predict any value accurately."
Misconception: A regression line can be used reliably far beyond the observed data.
Correction: Predictions outside the range of the original data (extrapolation) are often unreliable.

6. "Outliers should always be removed."
Misconception: Unusual data points are mistakes.
Correction: Outliers may represent genuine observations and can provide important information. They should be investigated before being excluded.

7. "The steepest regression line means the strongest correlation."
Misconception: A larger gradient indicates a stronger relationship.
Correction: The strength of correlation and the gradient of a regression line measure different things. A steep line does not necessarily indicate a strong correlation.

8. "All relationships are linear."
Misconception: Data patterns can always be represented by a straight line.
Correction: Many real-world relationships are curved or more complex and may require different models.

National Curriculum / Specification

AQA Specification reference:
S7.1, S7, S7.3
S8.1, S8.2 S8.3, S10.1
S9.1, S9.2, S9.3, S9.4, S9.5, S10.1