Module Content for Research Methods 1, 2 & 3 - King's College London

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How To Best Use These Notes

1. This educational content, valued at ~ £30,000, represents a significant investment in university-level learning materials. The extent to which you benefit from this content will be directly proportional to the level of effort and dedication you are prepared to invest in your studies.
1. Start by reading the Summary of Detailed Notes, which has all the high-level information you require to get the basics.
2. Don't read the original notes from top to bottom. Instead, identify the key terms or concepts you need to understand and use the find function to search the terms.
3. The author recommends using the Pomodoro technique to work through this content.
4. The author recommends teaching someone else these concepts for 5 minutes after a 25-minute learning session (you can *'teach'* an object on your desk or a real human).
5. You can **access the original slides for Research Methods 1, 2 & 3 here.**
6. You can **access the original notes for Research Methods 1, 2 & 3 here.**
7. You can **access the original code for Research Methods 1, 2 & 3 here.**

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Research Methods 1, 2 & 3 - Module Outline

Module 1 Outline

Educational Aims of the Module

The aim of this module is to provide students with the core research methods knowledge expected by the British Psychological Society (BPS). Additionally, the module introduces

students to reproducibility and open practices in research, trains them to use the programming language R for data analysis, and introduces mathematical concepts useful for understanding human behavior and brain function. This module is the first of three that aim to mold students into capable researchers who can carry out well-designed studies and critically evaluate scientific research.

Main Learning Objectives

By the end of this module, students will be able to:

1. Critically evaluate psychological and neuroscientific research, particularly focusing on group comparisons and correlational designs.
2. Use a range of quantitative techniques to analyze, report, and draw conclusions from data.
3. Understand and appreciate different research methodologies and their strengths and limitations.
4. Utilize R programming for organizing, pre-processing, and analyzing data.
5. Comment on issues related to reproducibility, open science, and animal experimentation in current research.
6. Produce comprehensive research reports.

Topics Covered

Topic 1: Good Research Practice (PTRR) | Measurement and Numbers (SCM)

- **Empiricism and Falsifiability**: Understand the importance of verifiable knowledge and the concept of falsifiability in science.
- **Variables and Measurement Errors**: Identify different types of variables and associated measurement errors.
- **Distributions**: Discuss properties and models of distributions, including centers and dispersion.
- **Using R**: Configure a computer to use R and manipulate numbers using R.

Topic 2: Human/Animal Behavior | Variability, Normality, and Symbols

- **Variability**: Explain the causes of variability and methods to minimize it.
- **Normal Distribution**: Recognize and evaluate the distribution of data.
- **Mathematical Conventions**: Understand conventions for and read simple formulae in mathematics.

Topic 3: Confounds & Control | Z-Scores and Equations

- **Biases in Research**: Explain biases and how to control for them in experimental design.
- **Z-Scores**: Compute and understand Z-scores.
- **Equations**: Understand different types of equations and their applications.

Topic 4: Manipulation & Control | Sampling & Linear Equations

- **Validity**: Describe the concepts of external and internal validity.
- **Factor Designs**: Understand factor designs and their limitations.
- **Sampling**: Distinguish between population parameters and sample statistics.
- **Standard Error**: Compute the standard error of the mean in R.

Topic 5: Directional and Third Variables | Confidence Intervals and Effect Sizes

- **Correlation vs. Causation**: Explain the difference and the limitations of third variables.
- **Confidence Intervals**: Compute and interpret confidence intervals.
- **Effect Size**: Define and understand the concept of effect size.

Topic 6: Random Assignment | Statistical Inference and Quadratics

- **Randomization**: Explain the benefits and limitations of randomization in experiments.
- **T-Tests**: Use t-tests to compare means.
- **Quadratic Equations**: Solve quadratic equations and visualize them in R.

Topic 7: Within Subjects | Null Hypotheses and Other Equations

- **Time and Order Effects**: Understand their impact on within-subject designs.
- **Hypothesis Testing**: Identify components of a hypothesis test and interpret p-values.
- **Equations Involving Logs and Exponents**: Solve and visualize these equations.

Topic 8: More Within-Subjects | Correlations, Linear Relationships & Inequalities

- **Ethical Issues**: Discuss ethical implications on experimental validity.
- **Linear Correlations**: Carry out and report linear correlations using R.
- **Inequalities**: Manipulate and solve inequalities.

Topic 9: Reading Visualization & Interpretation | Partial Correlations & Math Applications

- **Good vs. Bad Graphs**: Understand principles of effective data visualization.
- **Partial Correlations**: Appropriately carry out and report partial correlations using R.
- **Math in Neuroscience**: Apply mathematical tools to neuroscientific contexts.

Topic 10: Reproducibility | Frequentist vs. Bayesian Statistics

- **Reproducibility Crisis**: Explain current issues in psychology and neuroscience research.
- **Frequentist vs. Bayesian Approaches**: Describe and compare these statistical approaches.

Key Information About Assessments

- **Coursework**: Two pieces of coursework for PTRR and SCM, accounting for 40% of the final grade.
- **Research Diary**: Participation in research experiments and writing about the experience, contributing 10% of the grade.
- **Examination**: Multiple-choice and short answer exam covering all module content, making up 50% of the final grade.

Real-World Practical Applications

1. **Clinical Research**: Designing and analyzing clinical trials with rigorous statistical methods.
2. **Data Science**: Applying advanced data analysis techniques in various industries, including tech and finance.
3. **Psychological Research**: Conducting robust behavioral studies with a strong foundation in reproducibility and transparency.

These comprehensive notes provide a structured overview of the module, highlighting key topics, educational aims, and assessment details to ensure a thorough understanding of research methods and statistics in psychology and neuroscience.

Summary of Notes

Modules 1 & 2

Introducing Quantitative Statistics

Qualitative Methods:

- Involves testing theories using language.
- Common sources include magazines and articles.

Quantitative Methods:

- Involves testing theories using numbers.
- Process includes initial observations, identifying variables, and testing concepts by collecting data.

Key Concepts:

- **Theory**: A general principle or set of principles that explain known findings about a topic and generate new hypotheses.
- **Hypotheses**: Predictions derived from theories.
- **Falsification**: Disproving a theory or hypothesis.

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