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Evaluating & Researching University Participation Interventions

NERUPI Toolkit: Data Collection Strategies

Quantitative Analysis

20th June 2024

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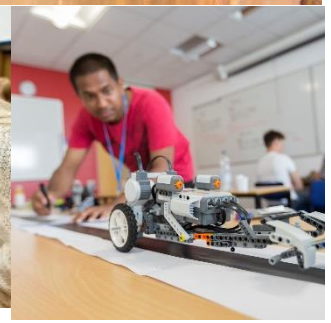

Types of data

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How can quantitative data help us to acquire a better picture and strengthen our evaluations?

Session plan

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1. Discussion of quantitative data and terms
2. Some key approaches to quantitative analysis
   - Descriptive statistics
   - Likert scales
   - Statistical testing
3. Hypothesis testing
   - Statistical models
4. Quality criteria for quantitative research
5. Resources and signposting

Session on qualitative analysis on 5th June 2024. Presentation available at:
https://www.nerupi.co.uk/members/events/nerupi-toolkit-data-analysis-strategies-session-1-qualitative-data-analysis

Accessing our data brain?

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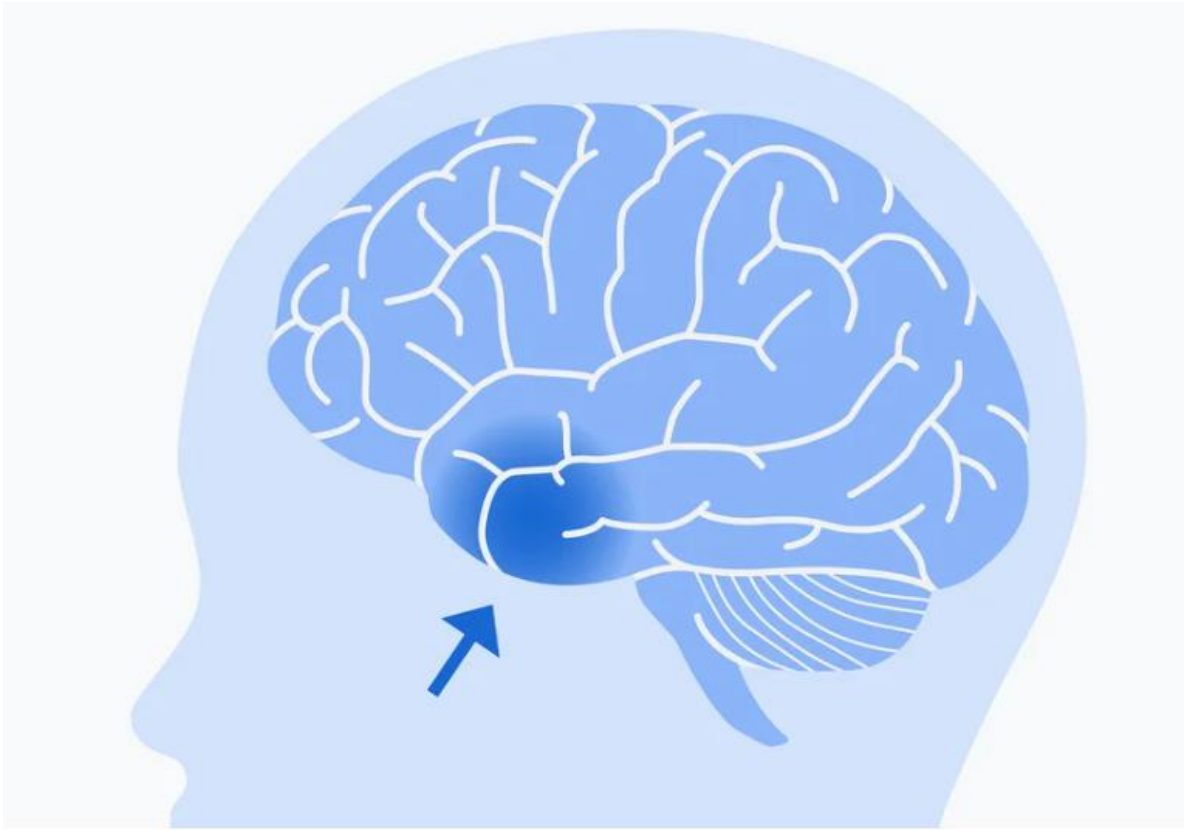

Credit: Google

https://blog.google/technology/research/google-ai-research-new-images-human-brain/

Some terms

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Cases	*Participants (people or other 'unit' of interest , e.g. schools)*
Variables	*Characteristics such as age, sex*
Independent variable	*Measure of participation*
Dependent variables	*Outcomes/results of participation*
Mean (average)	*Average value*
Median	*The 'middle' value of a dataset*
T-test	*Compares two Means*
p-value	*Probability of obtaining the study result*
Regression	*Method to estimate the relationship between the outcome and the intervention*

Descriptive and inferential statistics

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Descriptive statistics:

- Summary statistics – tables, graphs
- Characteristics of the dataset
- Usually numbers

Inferential statistics

- Make predictions and test hypothesis
- Based on assumptions and statistical tests
- Probabilities or percentages

Let's generate some data….

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Quiz questions:

On a scale of 1-5, how comfortable are you working with quantitative datasets?

Are you familiar with any statistical concepts, such as correlation, regression, or hypothesis testing? (Yes/No)

https://forms.office.com/e/7syxnnzEcu

Normal distribution

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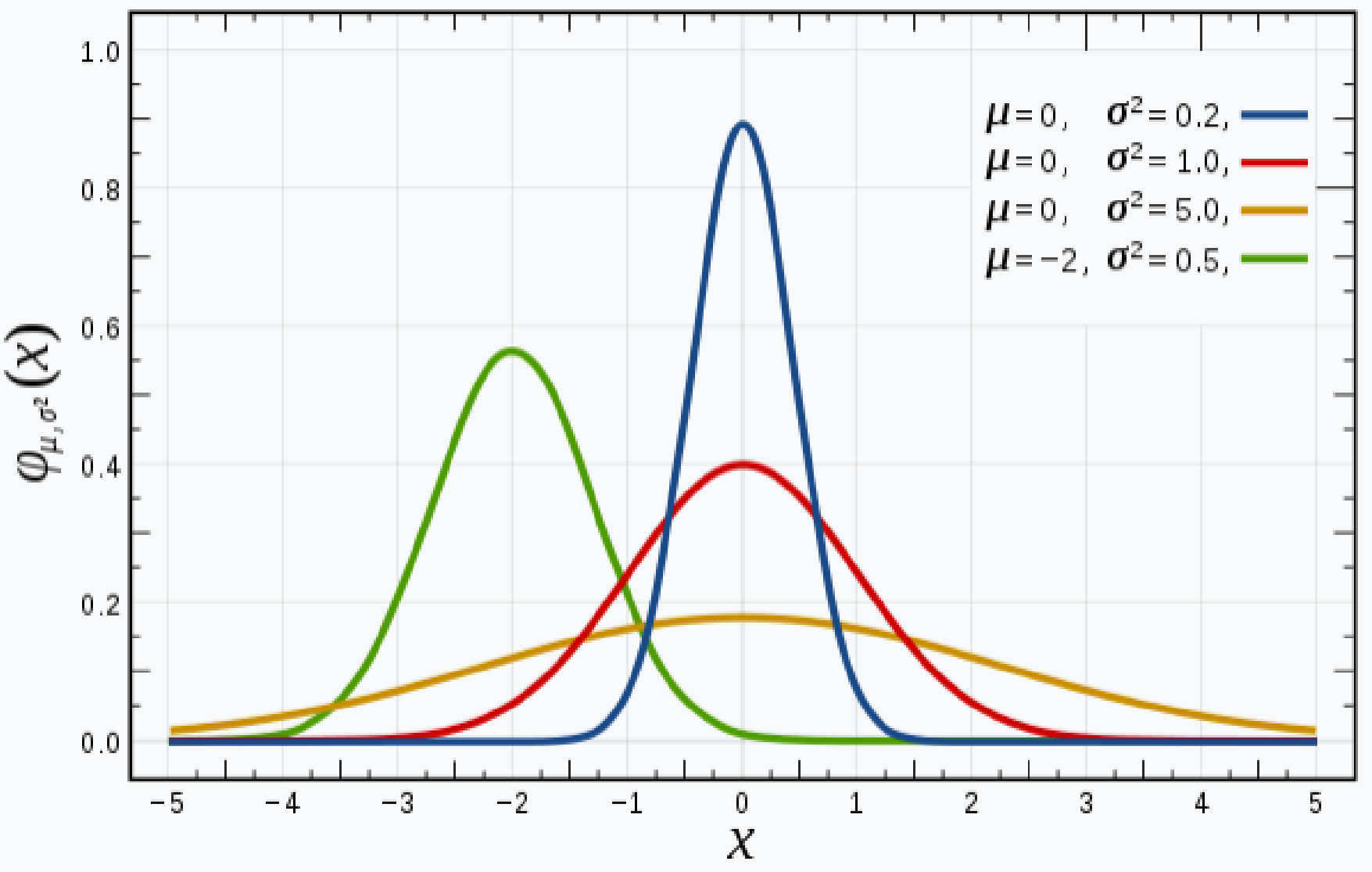

Normal distribution - Wikipedia

Different types of data

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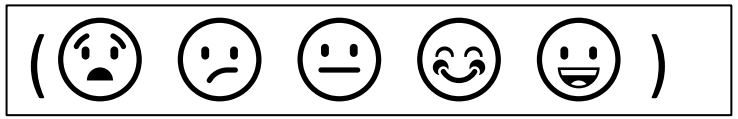
- Count or Frequency - Observations for each of the variables
- Interval – numerical variables you can arrange in continuous order with precise intervals such as height, weight
- Ordinal – measures that can be ranked in order but you cannot tell the interval between them, e.g. small, medium, large
- Categorical – Classifications, e.g. red, blue, green
- Binary – yes/no or 0/1



Organising your data

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	Variable A in column 1	**Variable B in column 2**	**Variable C in column 3**	**Variable D in column 4**	**Etc**
	Gender	No. of sessions	Applied to Uni	Agreement scale	
Case 1 in Row 1	Male	8	Yes	Agree	
Case 2 in Row 2	Male	6	No	Strongly agree	
Case 3 in Row 3	Female	7	Yes	Agree	
Case 4 in Row 4	Female	9	Yes	Agree	
Case 5 in Row 5	Male	5	No	Strongly disagree	

Etc

Categorical Interval Binary Ordinal

Outcome measures

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- One-shot (following an activity)
- Retrospective pre-test (recall of change following an activity)
- Pre- and post- design (before and after)
- Time series (before, during and after)
- Post- control group design (comparing results between groups)
- Difference in difference (comparing before and after measures between groups)

- **Quantifiable – objective rather than subjective**
- **Understandable – the 10 seconds test?**
- **Actionable – measures that you can actually impact**
- **Repeatable – ideally capture trends**
- **Timely – within scope**
- **Feasible – within time/resources etc**

Ways of analysing, interpreting, presenting

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Analysing

- Distribution
- Mean (average)
- Variability
- Cross-tabulation
- Filtering

Interpreting

- Making comparisons
- Range of views
- Qualitative & quantitative
- Before/after

Descriptive statistics

Presenting the data
Tables
Bar charts
Spider diagram

Likert scales

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- Type of closed ended question
- A satisfaction scale or a strongly agree scale
  - (usually 5 point scale)
- Extreme attitude range
- Numerical or descriptive

Simple before/after presentation

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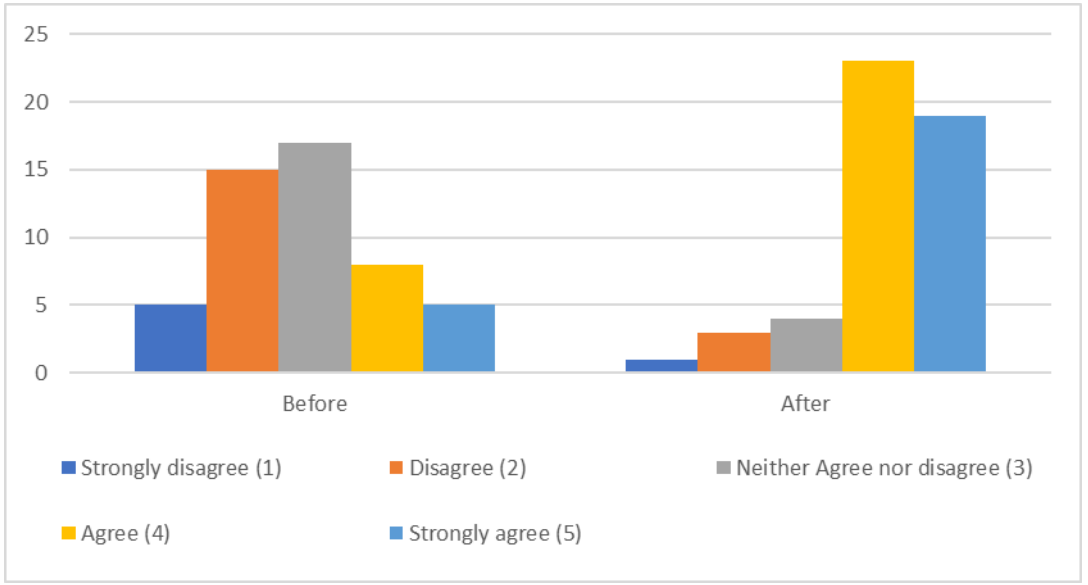
Number of responses		
	Before	After
Strongly disagree (1)	5	1
Disagree (2)	15	3
Neither Agree nor disagree (3)	17	4
Agree (4)	8	23
Strongly agree (5)	5	19
Number of responses	50	50
Mean	2.86	4.14



ASQ Validated Scales

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EXAMPLE -

TASO Transforming Access and Student Outcomes in Higher Education

Intermediate outcome: academic self-efficacy (prospective)

This is a scale for use with learners in schools, sixth-forms, or colleges, or young people not in education.

Prompt

The following statements relate to how you feel about studying in higher education from an academic perspective. Please consider each statement and indicate the extent to which you agree or disagree.

Items

1. I am confident that I can get the grades required to progress to university.
2. I have the academic ability to do well at university.
3. I could manage with the level of study required at university.

Response options, with coding

Strongly disagree (1) – Disagree (2) – Neither agree nor disagree (3) – Agree (4) – Strongly agree (5)

Analysis of ASQ

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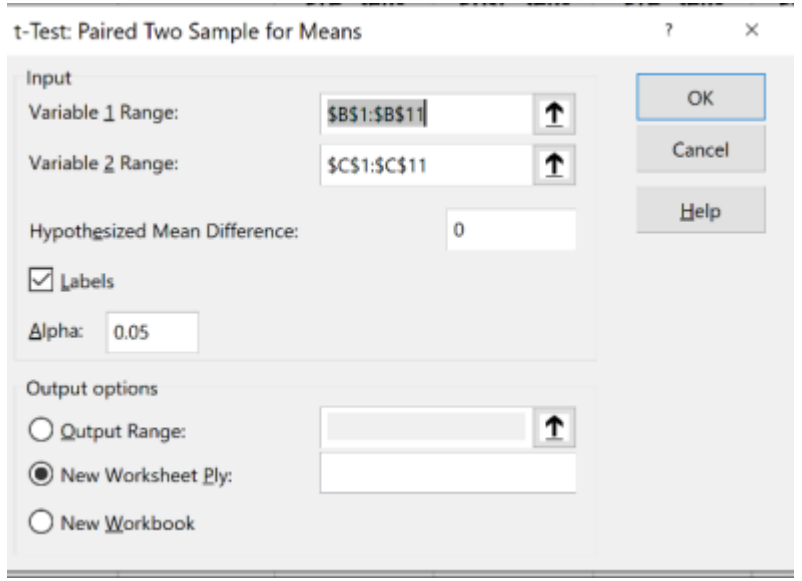
Pre and Post test design using paired t-test (assumes normal distribution)

Calculation of the effect size

The ASQ spreadsheet also calculates an overall score



Post-summer school scores for likelihood of applying to HE (M = 6.6) were higher than pre-summer school scores (M = 4.8). A paired samples t-test found this difference to be significant (t = -4.32, n = 10, one-tail p <0.001). The effect size is 1.44 which means that the post-summer school scores are more than a standard deviation higher than the pre-summer school scores. This is considered a large effect size.

https://s33320.pcdn.co/wp-content/uploads/TASO_excel_paired_t_test_guidance.pdf

Hypothesis testing

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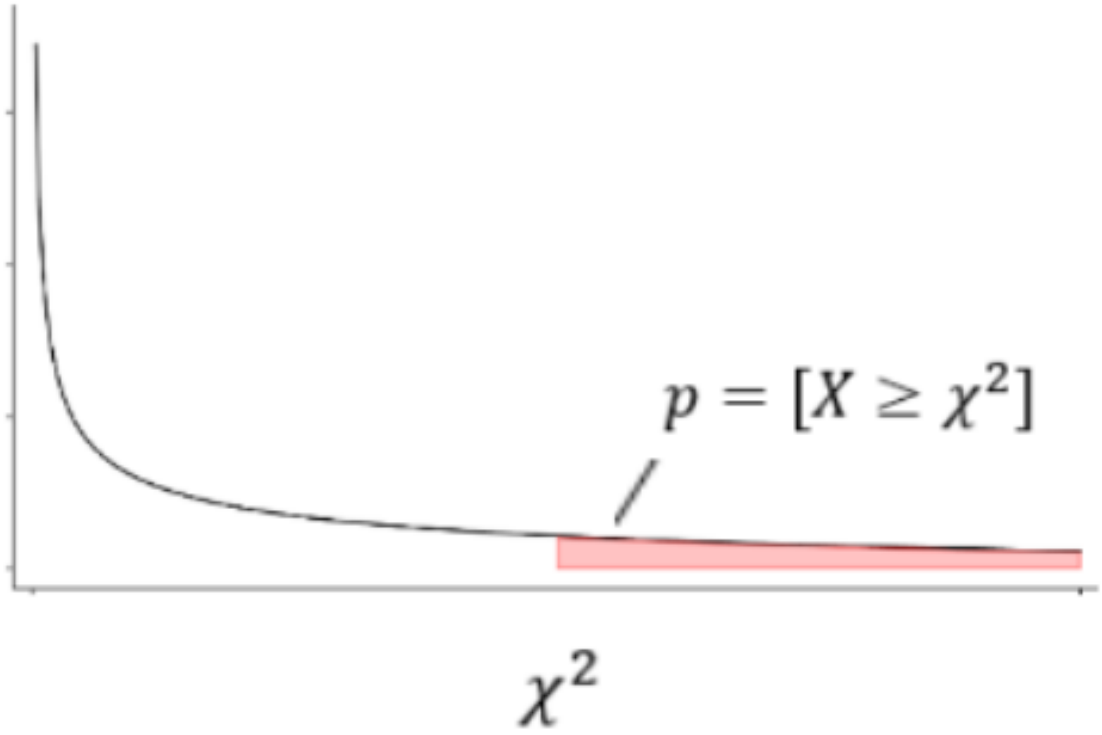
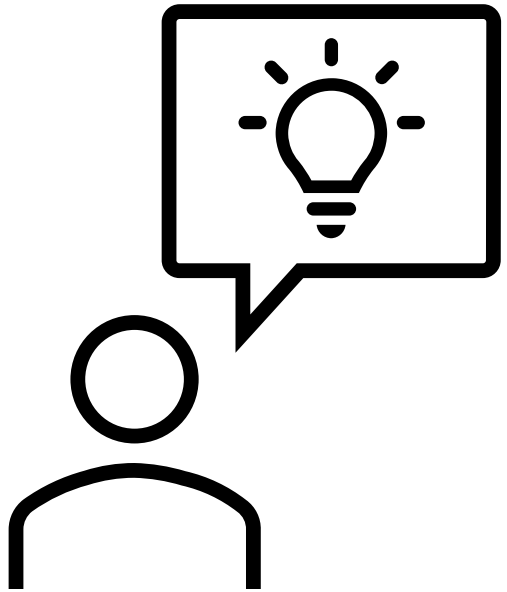
Hypothesis = a statement that can be tested





University of Kent Student Success Framework

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Null hypothesis:

The mean of the standard scores of students who attended the intervention was less than or equal to the mean of the standard scores of students who did not attend the intervention.

Alternative hypothesis:

The mean of the standard scores of students who attended the intervention was greater than the mean of the standard scores of students who did not attend the intervention.

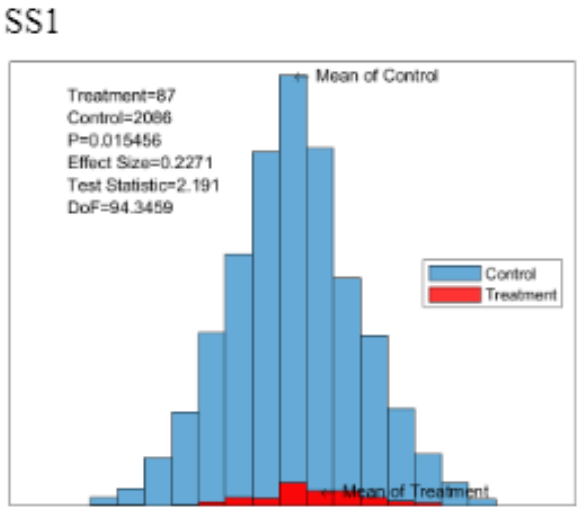

Figure 5 SS1 BAME attendance impact

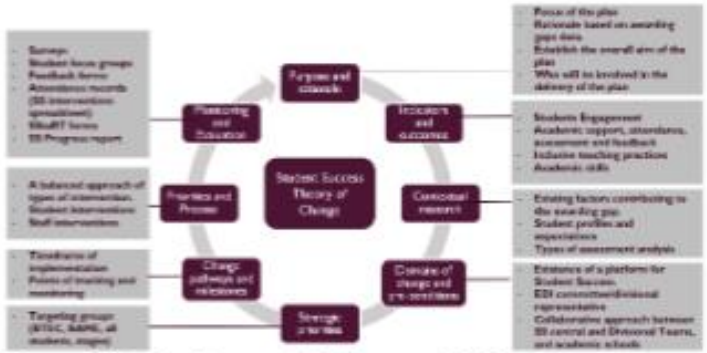

Figure 1 Student Success ToC Process Evaluation

Article at : https://osf.io/preprints/edarxiv/9v35b

Hypothesis testing

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1. Set up a null hypothesis.
2. Choose the measure to be tested.
3. Decide an appropriate distribution for your measure.
4. Choose an appropriate statistical threshold.
5. Run the test and interpret P-value.

Deciding what test to run

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Aim	Number of dependent variables	Dependent variable type & distribution	Number of independent variables	Independent variable type	Test
Comparing sample estimate with population value	1	Continuous & normal	0	NA	One sample t-test
		Continuous (skewed) or ordinal	0	NA	One sample median test
Comparing sample estimates	1	Continuous & normal	1 with 2 levels (independent groups)	Discrete: Binary	Two independent sample t-test (equal variances across independent variable groups)
			1 with 2 levels (independent groups)	Discrete: Binary	Two independent sample t-test (Welch's version for unequal variances across independent variable groups)
		Continuous (skewed) or ordinal	1 with 2 levels (independent groups)	Discrete: Binary	Wilcoxon rank test (also known as Wilcoxon-Mann Whitney test)
		Continuous & normal	1 with 2 levels (dependent/matched groups)	Discrete: Binary	Paired t-test
		Continuous (skewed) or ordinal	1 with 2 levels (dependent/matched groups)	Discrete: Binary	Wilcoxon signed rank test
		Discrete: Ordinal or nominal or binary	1 with 2 or more levels (independent groups)	Discrete: Ordinal or nominal or binary	Chi-squared test

Sample sizes and variability

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1

	Applied		
Summer school	Yes	No	Total
Yes	25 (50%)	25 (50%)	50
No	20 (40%)	30 (60%)	50
Total	45	55	100
P-value = 0.148			

2

	Applied		
Summer school	Yes	No	Total
Yes	50 (50%)	50 (50%)	100
No	40 (40%)	60 (60%)	100
Total	90	110	200
P-value = 0.041			

3

	Applied		
Summer school	Yes	No	Total
Yes	30 (60%)	20 (40%)	50
No	20 (40%)	30 (60%)	50
Total	45	55	100
P-value = 0.004			

4

	Applied		
Summer school	Yes	No	Total
Yes	52 (52%)	48 (48%)	100
No	46 (46%)	54 (54%)	100
Total	98	102	200
P-value = 0.228			

Multi-variate statistical analysis

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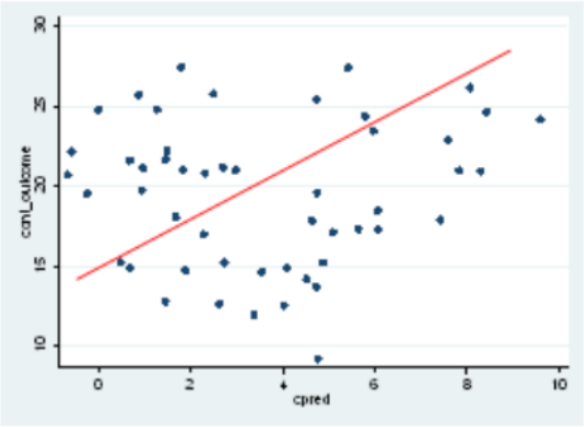
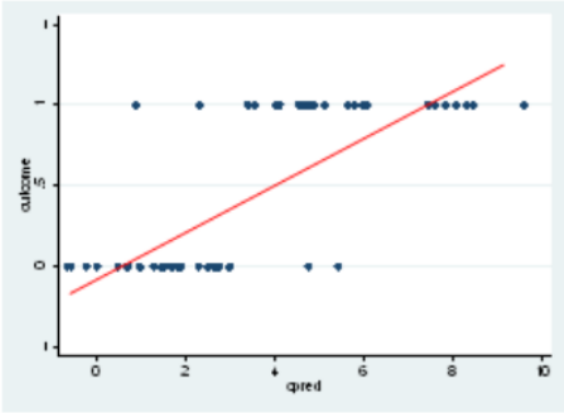
Regression analysis

- relationship between a dependent variable and one or more independent variables.

Linear regression: Continuous outcome variable (value)

Logistic regression: Binary outcome variable (probability based on odds





Graphs taken from Dr Victoria Cornelius, MSc Epidemiology/MPH, Lecture 7 Logistic Regression 2017 slides.

Used to:

- understand patterns of data
- study multiple factors at once
- make clear comparisons
- discard unwanted information
- reduce complexity

Parametric Statistical tests

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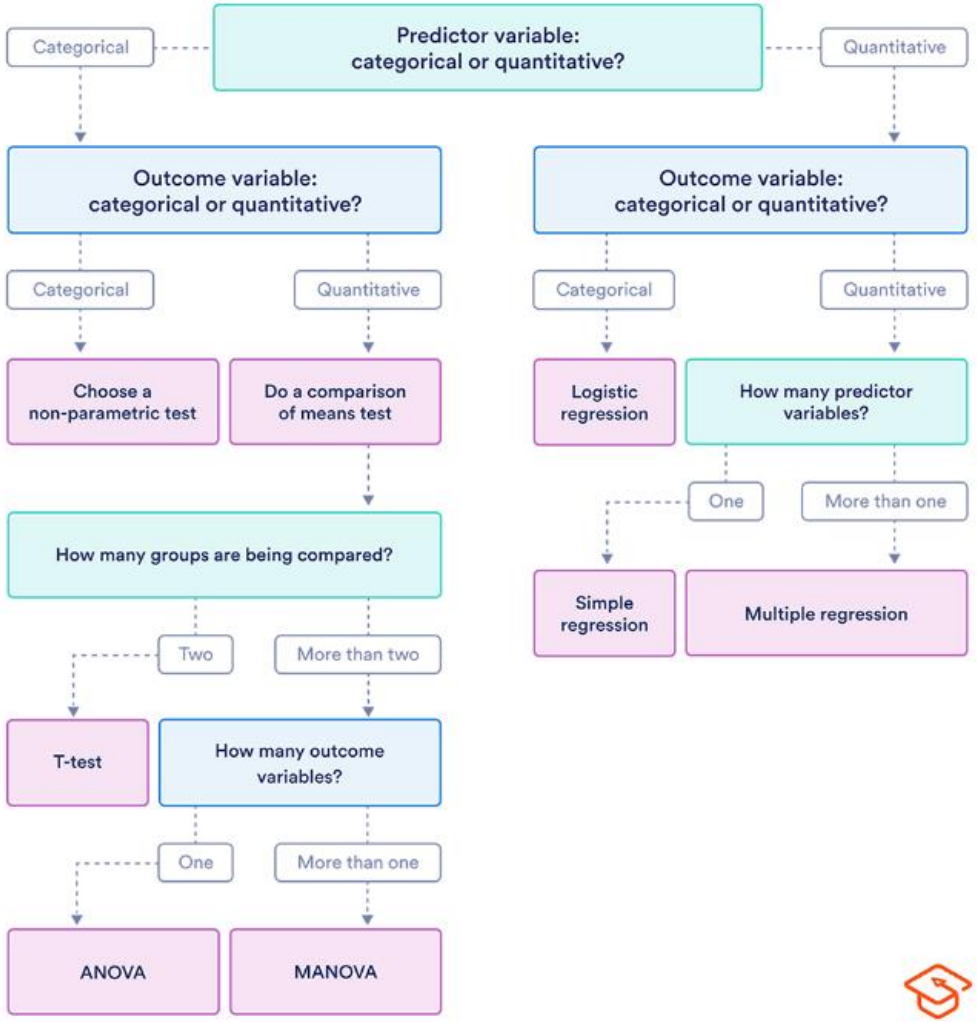

Scribbr

https://www.scribbr.com/statistics/statistical-tests/

Logistic Regression Modelling Example 1

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- Extra-curricular activities at NTU (Kerrigan & Manktelow, 2021)
  - Relationship between extra-curricular opportunities and participants' subsequent educational and occupational trajectories.
  - Used grade-based assessment scores, module pass/failure rates, final degree classifications and graduate progression rates to higher study or professional employment
- Participation is positively correlated with improved student outcomes, which holds when controlling for other key factors that influence student success, including gender, ethnicity, disability, age, subject area and pre-entry qualifications.

https://www.ingentaconnect.com/content/openu/jwpll/2021/00000023/00000001/art00007;jsessionid=8p45ii45i5k8a.x-ic-live-02#

Logistic Regression Modelling Example 2

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- UniConnect multi-intervention activities Aimhigher West Midlands (Burgess, Horton and Moores, 2021)
  - All eligible to participate in UniConnect activities but varied or did not participate at all.
  - Outcome measure was UCAS application success (acceptance onto a HE course) (collected via schools).
  - Three categories of independent variables included in this study: Participant-related (sex and ethnicity, deprivation), School-related (urban/rural) and UniConnect Intervention-related (Relative Risk of acceptance associated with increasing number of engagements).
- Engagement was associated with an improved chance of acceptance - type of engagement, extent and combination of engagement all mattered. Benefit beyond five or six engagements was small.
- Large differences in success between schools, even when controlling for several other variables.

Optimising the impact of a multi-intervention outreach programme on progression to higher educat recommendations for future practice and research - PMC (nih.gov)

Variables which influence HE

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- **Prior attainment**
- Gender
- Ethnicity
- POLAR quintile (HE access)
- IMD or IDACI quintile
- Free School Meals
- Parental experience of HE

Associations between characteristics of students (ABCs)
https://www.officeforstudents.org.uk/data-and-analysis/associations-between-characteristics-of-students/

Determining factors of access and equity in higher education: A systematic review - Mega Wanti, Renate Wesselink, Harm Biemans, Perry den Brok, 2022 (sagepub.com)

Evaluation considerations

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Work out project design features that will affect evaluation design:

- Target population and rules of selection
- The roll out plan
- Features and intensity (e.g. delivery modes, resources, different schemes)
- Availability of existing data
- Timing for data collection
- Data quality and variables
- 'Contamination' factors and how to control for these

Narrow down questions for evaluation:

- Questions aimed at measuring impact on a set of 'outcomes'
- Questions aimed at measuring effectiveness of different features/combinations of the project/programme
- Testing hypotheses questions and theory of change

Groupwork discussion
Working with statistical models

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- *Is using a statistical model approach useful in your specific context? If so, what would be the main purpose?:*
  - *Evaluate the effect of an intervention on the outcome*
  - *Understand more the effects different characteristics have on it*
  - *Establish what the predictors of the outcome are*
- *What outcome/result would you want to measure?*
- *What are your candidate variables for inclusion in your model?*

Ways to develop a data driven mindset (according to builtin)

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- Strive to be an expert in your data
- Understand what the data is for
- Prepare to get dirty
- Apply healthy scepticism to decisions regarding the data
- Accept that the answers you get might not be the answers you want
- Foster a data driven culture

5 Ways to Develop a Data-Driven Mindset | Built In

Quality criteria for qualitative research I

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- **Lincoln and Guba (1985)**

Quantitative	Qualitative
Internal validity	Credibility (confidence)
External validity	Transferability (applicability)
Reliability	Dependability (consistency over time)
Objectivity	Confirmability (neutrality)

Schwandt, T., Lincoln, Y.S, and Guba, E.G. (2007) Judging interpretations: But is it rigorous? trustworthiness and authenticity in naturalistic evaluation, *New Directions for Evaluation*, 115, pp.11-25. DOI: 10.1002/ev.223

Quality measures

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Criteria	Checks
Internal validity	Sample size for sufficient statistical power Describe details of context and intervention – Get information on non-responses
External validity	Use random sampling Replicate the study in other contexts Test the relationships between dependent and independent variables
Reliability	Estimate the internal consistency across repeated measures Estimate sources of variance affecting the measurement Estimate item, test, and person parameters
Objectivity	Use blinded assessors during data-gathering Audit trail for data for accountability Minimise data manipulation

Realist approach to impact

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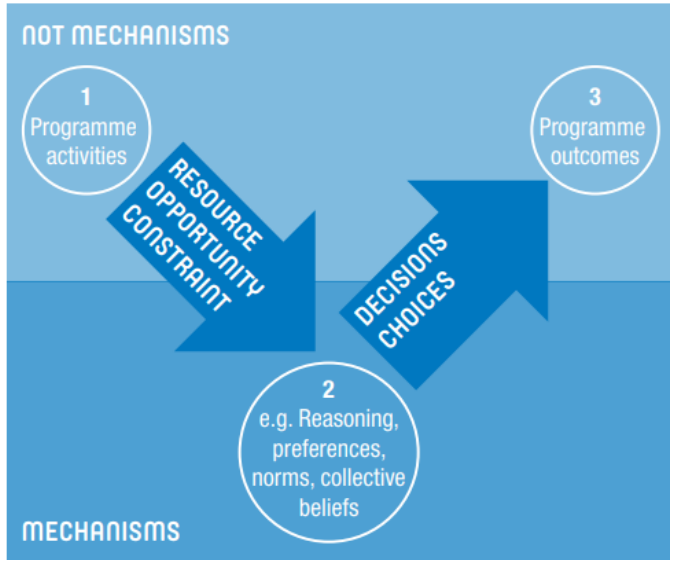
- Assumptions
  - Nothing works for everyone
  - Context makes a real difference to programme outcomes
  - Observation is subjective - shaped and filtered through the human brain
  - Outcome are the result of interactions within and across systems
  - Whether mechanisms 'fire' depends on the context
- Uses
  - Evaluating new initiatives or programmes
  - Where 'how and for whom' is not yet understood
  - Programmes with mixed patterns of outcomes
  - To know how to scale up
  - Understand how to adapt the intervention to new contexts



Pawson, R. and Tilley, N. (1997) Realistic Evaluation, Sage
Wong, G., Westhorp, G., Pawson R, and Greenhalgh, T. (2012)

Arriving at methods and sources

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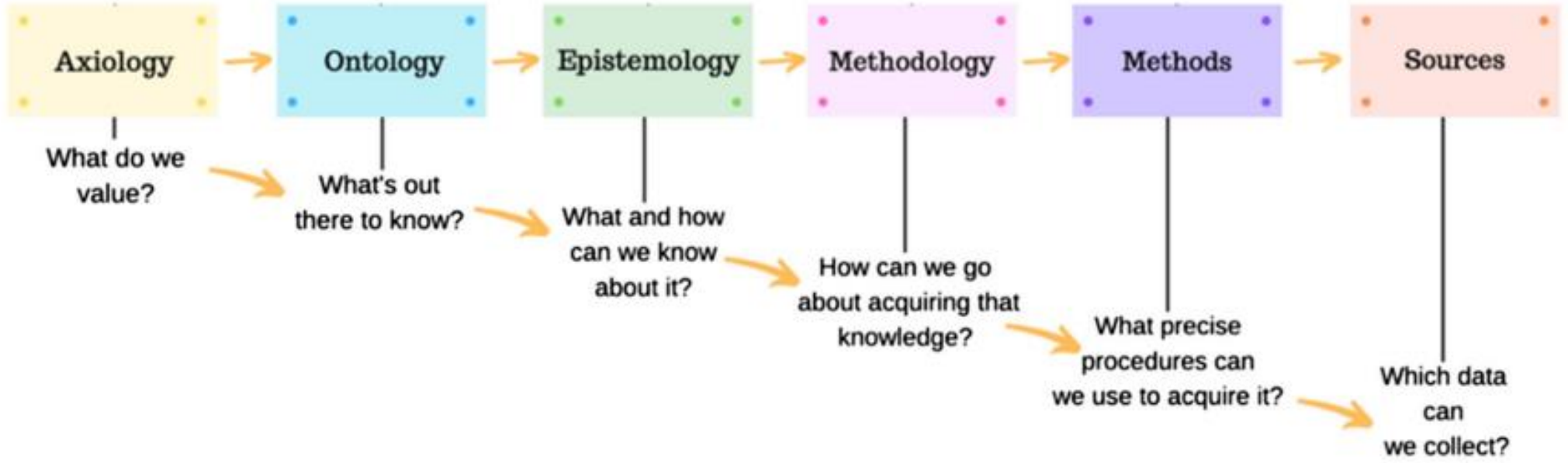

Brown et al (2019)
https://link.springer.com/article/10.1007/s40670-019-00898-9

Further information

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What aspects of quantitative analysis would you like more information or support on? (please tick those that apply and specify)

https://forms.office.com/e/y6xsgCgHuu

Excel Analysis TookPak

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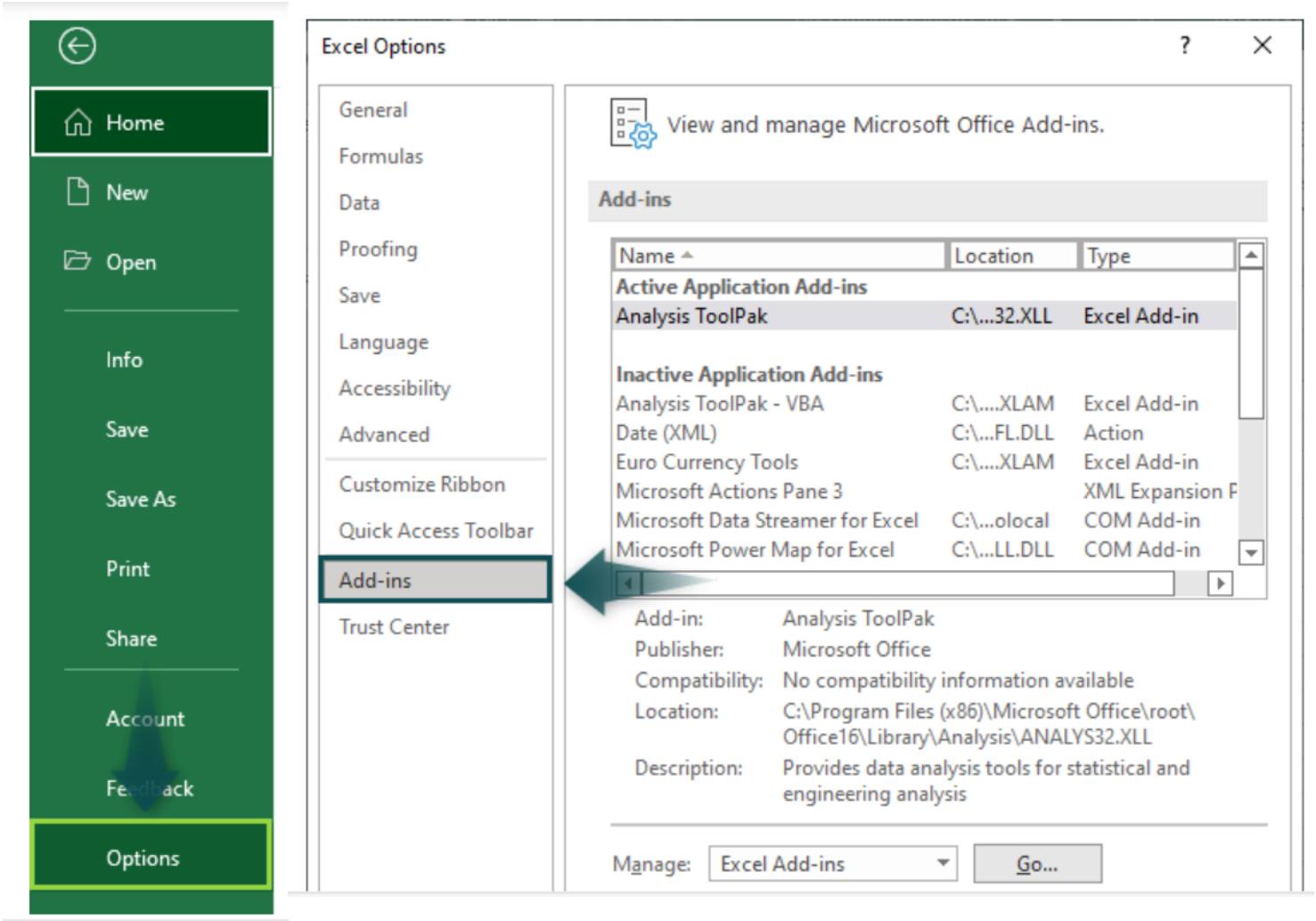

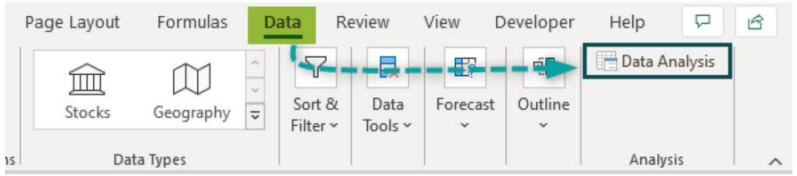

R-project

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https://www.r-project.org/

Resources

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- Experimental and quasi-experimental methods https://www.nerupi.co.uk/members/resources/experimental-quasi-experimental-methods
- Options for statistical analysis of pre/post tests and benchmarking https://www.nerupi.co.uk/members/resources/more-on-analysing-quantitative-data/options-for-benchmarking
- Khandker, Koolwal & Sawad (2010) Handbook on Impact Evaluation: Quantitative Methods and Practices, Washington: World Bank
- Bransby, T (2018) Data Fallacies to Avoid: An Illustrated Collection of Mistakes People Often Make When Analyzing Data, Data Science Central www.datasciencecentral.com/profles/blogs/data-fallacies-to-avoid-an-illustrated-collection-of-mistake
- Including Comparator Groups in HEAT's Tracking Reports https://vimeo.com/412251062/82df9543cb