October Block: Research Process

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This seminar is a group work (n=5-8). You should try to stay with the same group throughout the module. The task comprises of eight exercises focused on research process. You should work on these exercises using latex. The exercises are given below alongside with an extra background. To answer questions posed therein you will consider a given case study.

Case study: Cyber Security Awareness Training Research

1. **Background**

   A cyber security research project was conducted to evaluate the effectiveness of a cyber security awareness training program. The primary goal was to determine whether the training improved participants' knowledge of cyber security threats and enhanced their ability to identify and mitigate risks, such as phishing emails, weak passwords, and malicious websites. To assess the program's effectiveness, the researcher planned to measure participants' knowledge before and after completing the training.

2. **Research Design**

   For this study, the researcher chose to recruit participants from a large technology firm. The recruitment process focused exclusively on individuals working in IT-related roles, including system administrators, network engineers, and cyber security specialists. These individuals were selected primarily out of convenience, as they were readily accessible within the firm and exhibited a natural interest in cyber security. In total, 50 employees participated in the study.

   The participants underwent the cyber security awareness training, which covered key topics such as secure password management, identifying phishing attempts, and safe online behavior. After the training, the participants completed a post-training assessment, which was compared to their pre-training baseline knowledge test.

If you find it difficult to come up with a suitable/specific topic for the above case study, **as a last resort consider studying whether students who study more hours get higher exam scores**.

Latex

Throughout the module tutorials, you should work on the tutorial tasks using latex. This will enable you to develop familiarity with latex in readiness for coursework submission. Start a latex project in Overleaf and share it with your group members. Click Share within the project that you have created, enter the email IDs of your members. All members can now edit this document. Within this project, you should document the output of your tutorial work. As the module progresses, you will have created a useful portfolio of work. This will not be assessed.

Name: _____

Task

This comes in several parts as outlined below. Try to complete as much work as you can during today's seminar. Carry on working on the task outside the scheduled seminar time. Work collaboratively using latex.

- Submission deadline: Complete and record answers for all the parts by 16th October.
- By the deadline, upload your latex reports here: https://moodle.warwick.ac.uk/mod/assign/view.php?id=2618805

Independent study time

Between October and December block, **complete all the tasks for your specific final project topic** and prepare to discuss with the module tutor. You will produce the same latex output and share with the module tutor by 4th December 11pm: https://moodle.warwick.ac.uk/mod/assign/view.php?id=2618808

This work is not obligatory and will not be assessed, but there are several benefits in completing it. Upon request, you will receive formative feedback in December. This will also be an excellent staring point for working with your supervisor going forward.

1. Steps of empirical method

Research usually begins with a research question which is tested through experimentation (e.g., **"Does listening to vocal music during the learning of a word list have an effect on later memory for these words?"**).

Usually, the researcher has a certain theory regarding the topic under investigation. Based on this theory, statements or hypotheses will be proposed (e.g., **"Listening to vocal music has a negative effect on learning a word list."**).

From these hypotheses, predictions about specific events are derived (e.g., **"People who study a word list while listening to vocal music will remember fewer words on a later memory test than people who study a word list in silence."**).

These predictions can then be tested with a suitable experiment. Depending on the outcomes of the experiment, the theory on which the hypotheses and predictions were based will be supported or not, or may need to be modified and then subjected to further testing.

Exercise 1. Steps of empirical method

With your own research topic in mind:

1. Formulate one research question.
2. Propose statements or hypotheses based on a theory.
3. Formulate predictions about specific events derived from your hypotheses.

2. Research bias

Cognitive errors and human cognitive biases have the potential to greatly affect objective scientific study and results. Bias is an often misused term that when used correctly, describes irrational, systematic errors that deviate from rational decisions and cause inaccurate results. Bias is not the same as incompetence or corruption, though those also interfere with neutral scientific inquiry.

In research, bias occurs when "systematic error [is] introduced into sampling or testing by selecting or encouraging one outcome or answer over others". Bias can occur at any phase of research, including study design or data collection, as well as in the process of data analysis and publication.

Three biases that are especially useful to beware of as you think about science are:

1. **Confirmation bias** which is the human tendency toward searching for or interpreting information in a way that confirms one's preconceptions, beliefs, or hypotheses, leading to statistical errors. This bias is often unconscious and unintentional rather than the result of deliberate deception. Remember that scientific thinking should seek and consider evidence that supports a hypothesis as well as evidence that falsifies the hypothesis. To avoid confirmation bias, try to keep an open mind and look into surprising results if they arise. Do not be afraid to prove yourself wrong!

2. **Confirmation bias** which prevents us from finding unbiased scientific truths and contributes to overconfidence. Daniel Kahneman, author of Thinking Fast and Slow, uses the acronym WYSIATI, for "what you see is all there is," to describe overconfidence bias. Kahneman says that "we often fail to allow for the possibility that evidence that should be critical to our judgment is missing—what we see is all there is." Without conscious care, there is a natural tendency to deal with the limited information you have as if it were all there is to know.

3. **Hindsight bias** which leads people to say "I knew that would happen" even when new information distorts an original thought. Hindsight also causes us to undervalue the element of surprise of scientific findings. As you pursue science and scientific experimentation, keep biases in mind and continually ask yourself whether or not you think a bias is affecting your scientific processes or outcomes.

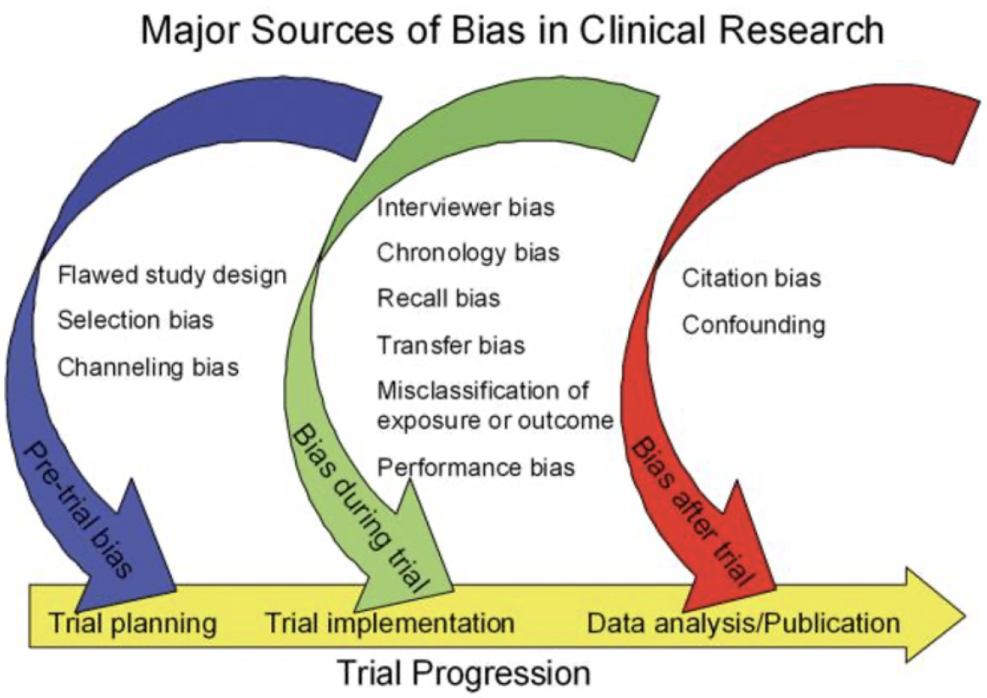
Other types of bias include:

- **Researcher bias** that occurs when the researcher conducting the study is in favour of a certain result. Researchers can influence outcomes through their study design choices, including who they choose to include in a study and how data are interpreted.

- **Selection bias** that refers to influencing outcomes through study design choices, including who is included in a study and how data are interpreted.

- **Information bias** that occurs as a result of systematic errors during the collection, recording or analysis of data.

There are many other types of bias in research as shown on the figure below.



Pannucci, C.J. and Wilkins, E.G., 2010. Identifying and avoiding bias in research. *Plastic and reconstructive surgery*, *126*(2), pp.619-625.

When bias occurs, a study's results may not accurately represent phenomena in the real world, or the results may not apply in all situations or equally for all populations. For example, if a research study does not address the full diversity of people to whom the solution will be applied, then the researchers may have missed vital information about whether and how that solution will work for a large percentage of a target population.

Bias can also affect the development of engineering solutions. For example, a new technology product tested only with teenagers or young adults who are comfortable using new technologies may have user experience issues when placed in the hands of older adults or young children.

Exercise 2. Research bias

The case study was subject to several biases that impacted the validity and generalizability of the findings.

1. Identify biases introduced. How were they introduced?
2. What are the consequences of these biases?
3. Offer recommendations to avoid these biases in future research.

3. Formulating research question

Creating a research question can be a tricky process, but there is a specific method you can follow to ease the process.

1. You should start with a broad topic. This should be topic you are genuinely interested and recently addressed by the research community.

2. Do preliminary research to learn about topical issues.
3. Narrow down your topic and determine potential research questions.
4. Evaluate the soundness of your research question. Use FINER" criteria.
5. Construct your research question properly. Use frameworks like PICOT, PEO, SPIDER, CLIP.

A. Narrow down your topic

There are several techniques you can use to help you narrow down your topic. These include:

- **"Gap-spotting"**. Construct questions out of identified limitations in literature and overlooked areas of study. Similarly, choose questions that extend or complement the findings of existing literature.
- **Problematization**. Challenge your views or knowledge of the area of study.
- **Reflection**. Reflect on patterns, trends and problematic areas of practice.

B. Evaluate the soundness of your research question

Your initial research and review of related literature will have produced some interesting questions that seem like they are worth pursuing. However, not all interesting questions make for sound research questions. Keep in mind the research question meaning - that a research question draws its answer or conclusion through an analysis of evidence.

Hulley et al. (2007) suggest using a set of criteria - known as the "FINER" criteria - to find out if you have a good research question. The FINER criteria are outlined below.

- **F - Feasible.** A good research question is feasible, which means that the question is well within the researcher's ability to investigate. You should be realistic about the scale of their research as well as their ability to collect data and complete the research with their skills and the resources available to them. It is also wise to have a contingency plan in place in case problems arise.
- **I - Interesting.** The ideal research question is interesting not only to the researcher but also to their peers and community. This interest boosts the researcher's motivation to see the question answered.
- **N - Novel.** Your research question should be developed to bring new insights to the field of study you are investigating. The question may confirm or extend previous findings on the topic you are researching, for instance.
- **E - Ethical.** This is one of the more important considerations of making a research question. Your research question and your subsequent study must be something that review boards and the appropriate authorities will approve.
- **R - Relevant.** Aside from being interesting and novel, the research question should be relevant to the scientific community and people involved in your area of study. If possible, your research question should also be relevant to the public's interest.

C. Construct your research question properly

There are a number of frameworks that you can use for properly constructing a research question. One such framework is PICOT.

The PICOT research question framework was first introduced in 1995 by Richardson et al. Using the PICOT framework, research questions can be constructed to address important elements of the study, including the population to be studied, the expected outcomes, and the time it takes to achieve the outcome:

- P – Population, patients, or problem.
- I – Intervention or indicator being studied.
- C – Comparison group.
- O – Outcome of interest.
- T – Timeframe of the study.

P	I	C	O	T
Patient / **P**opulation	**I**ntervention / **I**ndicator	**C**ompare / **C**ontrol	**O**utcome	**T**ime / **T**ype of Study or Question
Who are the relevant patients? Think about age, sex, geographic location, or specific characteristics that would be important to your question.	What is the management strategy, diagnostic test, or exposure that you are interested in?	Is there a control or alternative management strategy you would like to compare to the intervention or indicator?	What are the patient-relevant consequences of the intervention?	What time periods should be considered? What study types are most likely to have the information you seek? What clinical domain does your question fall under?

With these elements, the framework is more commonly used in clinical research and evidence-based studies.

Figure below shows a sample research question illustrating how to write a research question based on the PICOT framework and its elements.

Between the ages of five and 18, are children of parents with diagnosed mental health issues at increased risk of depression or anxiety compared with children of parents with no diagnosed mental health issues?

P (population being studied)	children
I (indicator or intervention)	parents with diagnosed mental health issues
C (comparison group)	children of parents with no diagnosed mental health issues
O (outcome of interest)	increased risk of depression or anxiety
T (timeframe of interest)	between the ages of five and 18

Exercise 3. Formulating research question

1. Write your own research question according to PICOT.
2. Evaluate the soundness of the question using FINER.

4. Operationalizing concepts effectively

The following three steps can be used to operationalize concepts effectively:

1. Outline the **concepts** you want to study.
2. Select **variables** to represent each concept.
3. Select **variable indicators**.

The concept you are trying to study will influence your research question. A research question is a question that a research study sets out to answer. For example, let's assume you want to study the effects of social media on depression among teenagers. Your research question would be as follows:

- **"What is the effect of social media use on the mental health of teenagers?"**

The concepts being studied in this question are **social media use** and **depression**.

The next step is to clearly define which variables you are going to measure. Your main concept may have a range of different variables that are measurable, however, you must select the variables that will help you answer your research question best. You can even select variables by reviewing previous literature on the same concept to discern the most relevant variables.

- For example, you can measure **'how often teenagers use social media' (frequency) or you can track 'which social media they use' (type)**.

Once you have selected a variable to represent each concept being measured, you can decide on the indicators for the different variables. These indicators will represent your variable numerically, allowing you to measure and evaluate them. For this step, too, you can refer to past literature to get an idea of the different practical ideas that can be implemented to measure your selected variables. Let us assume that the variable you decided to select while measuring social media behaviour is frequency.

- In this case, the indicator of frequency could be **the number of logins during the day or the total amount of time spent cumulatively on social media on a daily basis**.

Exercise 4. Operationalization

1. Operationalize your research by outlining the concepts you want to study.
2. Then select best variables and their indicators.

5. Constructing conceptual framework

In the class we learnt about different types of data. To reiterate, data is generally divided into two categories: Primary (data collected from an original source) and Secondary (data collected from a secondary source). Data can be also quantitative and qualitative. Quantitative data represents amounts. Categorical data represents groupings. A variable that contains quantitative data is a quantitative variable; a variable that contains categorical data is categorical variable. Each of these types of variable can be broken down into further types.

When conducing experiments, you also need to know what constitutes dependent and independent variables, in addition to many other types of variables, such as controlling, confounding, moderating, mediating variables, etc.

Knowing data/variable types is important for at least three reasons:

- Based on the data you want to collect you can **decide on suitable method(s)**.
- Once you have defined your independent and dependent variables and determined whether they are categorical or quantitative, you will be able to **choose the correct statistical test**.
- It is also useful to map relationships between your variables to **define the relevant objectives for your research process** and maps out how they come together to draw coherent conclusions. This is known as conceptual framework.

You should construct your conceptual framework before you begin collecting your data. Conceptual frameworks are often represented in a visual format and illustrate cause-and-effect relationships.

Exercise 5. Conceptual framework

Develop a conceptual framework (written or visual) based on a literature review of existing studies about your topic:

1. Choose/formulate your research question. Your research question guides your work by determining exactly what you want to find out, giving your research process a clear focus.
2. Identify your independent and dependent variables and visualise your expected cause-and-effect relationship.
3. Identify other variables that can influence the relationship between your independent and dependent variables. Some common variables to include are moderating, mediating, and control variables.
4. Expand the framework by adding a mediating variable. Mediating variables link the independent and dependent variables, allowing the relationship between them to be better explained.
5. Lastly, control variables must also be taken into account. These are variables that are held constant so that they do not interfere with the results. Even though you are not interested in measuring them for your study, it is crucial to be aware of as many of them as you can be.

6. Conducting literature review

A general literature review starts with formulating a research question, defining the population, and conducting a systematic search in scientific databases. The latter requires systematic approach and involves devising **search methodology and strategy**.

Once you have completed searches of the databases and identified all studies that answer your research question and fit within the inclusion and exclusion criteria you have chosen, you will begin your **data analysis**, which involves the following three steps:

- Identifying the findings in each study that answer your research question (aim).
- Condensing and summarizing these findings.
- Grouping the findings thematically into categories that speak to your research question.

Article matrix. The first step is to get an overview of all identified studies by making an article matrix where you describe each study's **aim, methods and results**, especially those results that are relevant to your particular research question. Table below shows examples of how this might look like.

Table 1. Example of an article matrix summarizing studies for use in a general literature review.

Research question: (Write your research question at the top of the matrix; the articles used in this example answer different research questions.)				
Art. nr	Reference	Aim	Method *Describe concisely & use the same format for each article*	Results *Summarize the study results with a focus on the results of relevance to YOUR literature study*
1	Bahl, A., Pandurangadu, A. V., Tucker, J., & Bagan, M. (2016). A randomized controlled trial assessing the use of ultrasound for nurse-performed IV placement in difficult access ED patients. *American journal of emergency medicine 34*, 1950-1954.[7]	To analyse outcomes associated with nurse-performed ultrasound (US)-guided intravenous (IV) placement compared to standard of care (SOC) palpation IV technique on poor vascular access patients.	RCT 122 participants 63 randomized to ultrasound 59 to standard of care Trauma center Nurses were trained to use US-guided IV placement in the study's first phase. Successful IV placement and time to placement measured.	Success rate for placement: Ultrasound: 76% (48/63 patients) Standard of care: 56 % (33/59 patients) (p=.02) Mean time to placement: Ultrasound: 20.7 min Standard (palpation): 15.8 min (p= .75)
2	Mayan, M., Robinson, T., Gokiert R., Tremblay, S., Abonyi; Long (2017). Respiratory isolation for tuberculosis: the experience of indigenous peoples on the Canadian prairies. *Public Health Action 7*(4), 275–28.[8]	To understand how indigenous peoples with tuberculosis in Canada experience respiratory isolation.	Semi-structured interviews 48 adults, 17-62 years, men and women Qualitative content analysis	Participants described • Feeling trapped, anxious over being confined, like being in jail • Feeling bored • Missing their families and feeling sad and disconnected • Difficulty being away from their children • Loneliness

Validity and reliability. You should note each study's validity and reliability. For example, a study with a large sample, careful randomization, and few confounding factors, will produce a more trustworthy result than a study with a smaller sample, selection bias, no randomization, and many confounding factors. The validity and reliability of particular studies can be woven into your synthesis of results or discussed separately at the end of your results section.

Golden advice. Synthesize and draw conclusions instead of listing studies. Write category by category, rather than study by study.

Exercise 6. Search methodology and strategy

When writing your search methodology and strategy, you should give enough detail for someone else to reproduce the same or similar results.

A. Write up your search methodology

Your search methodology should include:

- Where you searched (e.g. database names).
- When you did your searches (e.g. date viewed or retrieved).
- Limits you applied to your searches (e.g. date ranges, language, document type, etc.).

B. Write up your search strategy

Your search strategy should include:

- How you searched (e.g. keywords and/or subjects).
- Search terms used (e.g. words and phrases).
- Search techniques used (e.g. nesting, truncation, etc.).
- How you combined searches (e.g. AND / OR / NOT).
- Number of hits (articles found).

Record your results for all your databases. Note you may have different strategies for different databases. It is a good practice to examine 2-3 databases.

Now produce a table compiling all the data above (methodology and strategy). Similar table should be included in your dissertation as an appendix to a literature review.

Exercise 7. Article matrix and literature mapping

Record results of your literature search in a table or a chart/tree map.

- Start to categorize the literature you have found around some broad organizing logic (e.g., by theory, method, time period, etc.).
- Label each column based on your organizing logic.
- Specify major publications. You may want to add a column that provides some kind of description or detail.
- Consider adding additional layers of analysis to include other relevant 'sub-topics'.
- In the case of flow chart or 'tree' style literature maps, use lines to connect or signify a shortcoming, strength, or synergy between two or more groupings of the literature.

There is no preset number of columns you should have – the data in conjunction with your particular research question will govern how much synthesizing and abstraction is required.

Exercise 8. Validity and reliability

Coming back to the article matrix, critically review reliability and validity of your literature review.

- Add additional column and name it "validity and reliability".
- Record what have other researchers done to devise and improve methods that are reliable and valid.