foRMAtion

Lesson 2 - Introduction to research design, research methods and research life cycle

Keywords

- Research questions
- Literature review
- Quantitative data
- Qualitative evidence
- Scientific publications
- Peer review
- Open data
- Research lifecycle

Learning Objectives

② ③ ⑥ ⑦
⑧ ⑪ ⑫ ⑬

Scan for complete LOs

Go to the exercise

https://learningapps.org/watch?v=pr8x7fpin22

Is there a scientific method that is common to all scientific disciplines? A method that pervades all sciences in implicit contrast with all specialised methods for research applied to some sciences? There is a difference between specialised methods and general principles. Precisely because specialised techniques are specific, and each scientific discipline has its own set of techniques. Simultaneously, the entire scientific community has a set of shared principles, which guide the way research is carried out.

In the previous lesson, we have seen some of the basic ideas defining what research itself is. In doing so, we touched upon the scientific method by introducing ideas of controlled observation, inductive and deductive reasoning, formulation of hypotheses and experimentation. As a continuation, this lesson will focus on the general principles that guide researchers from different fields in designing their research projects.

Research design

Research design provides the structure for research and helps organise ideas better. It is important to dedicate time to thinking about the research design of your project. King et al. (1994) consider research design as divided into four main components i) **research question**; ii) **theory**; iii) **data** and the iv) **use of data**. A major component of the research design is the **methods**.

The research design will depend on the type and purpose of the research. Research serves two purposes:

- **fundamental research** - (also called basic/ pure, blue-sky research) aims to contribute to the theoretical understanding of how the world works. It is driven by curiosity and generates new ideas.

- **applied research** – aims to address real-world problems and provide solutions for those problems.

i) Identifying a research question

Formulating a clear research question is vital in science because it determines the data to collect, the methods to use, and, ultimately, the success of a project. Developing a research question is an iterative process of reading and thinking, to define a problem and specify the contribution that can be brought by the researcher when attempting to solve the question. Research questions are theoretical. They address something that we do not yet know. The theoretical research question is always broader than the specific case study that the researcher chooses to examine. Often it is said that the research question attempts to understand "the big picture".

Research ideas begin with something that interests us, which we narrow to a topic, and from there to a question that we can address. They develop out of theory, observations, and a variety of other sources.

The research question or hypothesis is a statement or a tentative argument (about the relationship between two or more variables) that poses the research question and proposes expected results.

The hypothesis can be researched in two different ways:

- *By collecting evidence that tests the validity of the hypotheses* - in this case, the hypothesis is formulated as an affirmative sentence that makes some sort of prediction (Example: Cars need oil to function);

- *By using the hypothesis as a guide to a process of discovery* (exploratory research) (Halperin & Heath, 2012) – in this case evidence is collected to make inductive inferences from it.

Examples of research questions in social sciences can be found here: https://www.scribbr.com/research-process/research-question-examples/

In experimental sciences, identifying the hypothesis is part of a research cycle that involves the following different steps**:**

1. Observation and description of a natural or human phenomenon
2. Desk research (or literature review) about the topic of the research question
3. Asking a question and formulating a hypothesis to explain the observed phenomena
4. Predicting the hypothesis
5. Testing/Experimenting the hypothesis
6. Drawing conclusions
7. Making recommendations for further research areas

ii) Theory: function of the literature review

Fink (2005) defines literature review as a systematic, explicit, and reproducible method for identifying, evaluating, and synthesising the existing body of completed and recorded work produced by researchers, scholars, and practitioners. Performing a literature review is a mandatory exercise when conducting research due to the following reasons:

1. It allows the researcher to contextualise and argue his/her research idea within the existing theories and evidence on the topic;
2. It allows the researcher to place his/her research question in literature and defend the need for research on the topic by identifying areas of knowledge that are still unexplored (known as *gaps* in the literature).

iii) Data and methods

To collect relevant data that allows us to answer the research question, the researcher must follow a scientific method. A major component of the research design is the research method that will be used.

In this section, we will briefly introduce some types of scientific methods, knowing that there are many other methods as each research field tends to develop ways to collect evidence from its research objects.

Adequate scientific methods to address a given research question, need to take into consideration the difference between these objects of study: natural or social. While natural objects are precise, accurate and deterministic, social objects are naturally less precise and deterministic (Bhattacherjee, 2012). Consequently, natural sciences will be more precise, accurate and deterministic than social sciences. We often collect **qualitative data** (example: discourse from interviews) when performing social sciences, while the natural sciences typically collect **quantitative evidence** (example: number of occurrences, temperature, pH, etc.).

The main characteristics of the most used scientific methods in social sciences are:

1. **Survey Research**. This technique is based on the selection of a "sample" that is representative of the population of respondents to a questionnaire. The data collected can be qualitative and quantitative, depending on the questions and the purposes of the research. Types of surveys: Cross-sectional surveys, run regularly but to different individuals, and longitudinal surveys, run to the same individuals over time.

2. **Discourse analysis**. The linguistic/semiotic analysis of discourse is used to study the meaning of language (spoken or written/textual) in the representations of social life. Sources of data in discourse analysis: Primary qualitative material, such as interviews or focus groups; or secondary material, such as archive material, analysis of social or traditional media, advertisements, films, political speeches, or policy documents.

3. **Mixed-methods** research. It combines different scientific methods to create a framework of analysis using both quantitative and qualitative data.

The most used scientific method in natural sciences is the **experimental method**. Indeed, when possible, natural scientists conduct experiments in which they impose conditions upon the phenomena being studied, so that, to the greatest extent possible, only one factor can vary. In a laboratory, all conditions such as light, temperature or humidity can be controlled. In the field, conditions can be more variable, but if the experimental treatment and the **control** are side by side, the variability of all factors except the one being studied might be the same and, therefore, the conditions for an analysis are not present. Experiments are not always possible: the object of study can be too big (a mountain, for example), or too complex (an ecosystem, for example).

Saunders et al, (2007) have developed the *Saunders Research onion* that illustrates how different elements involved in the research could be examined to develop the final research design, integrating many of the methods and approaches defined above.

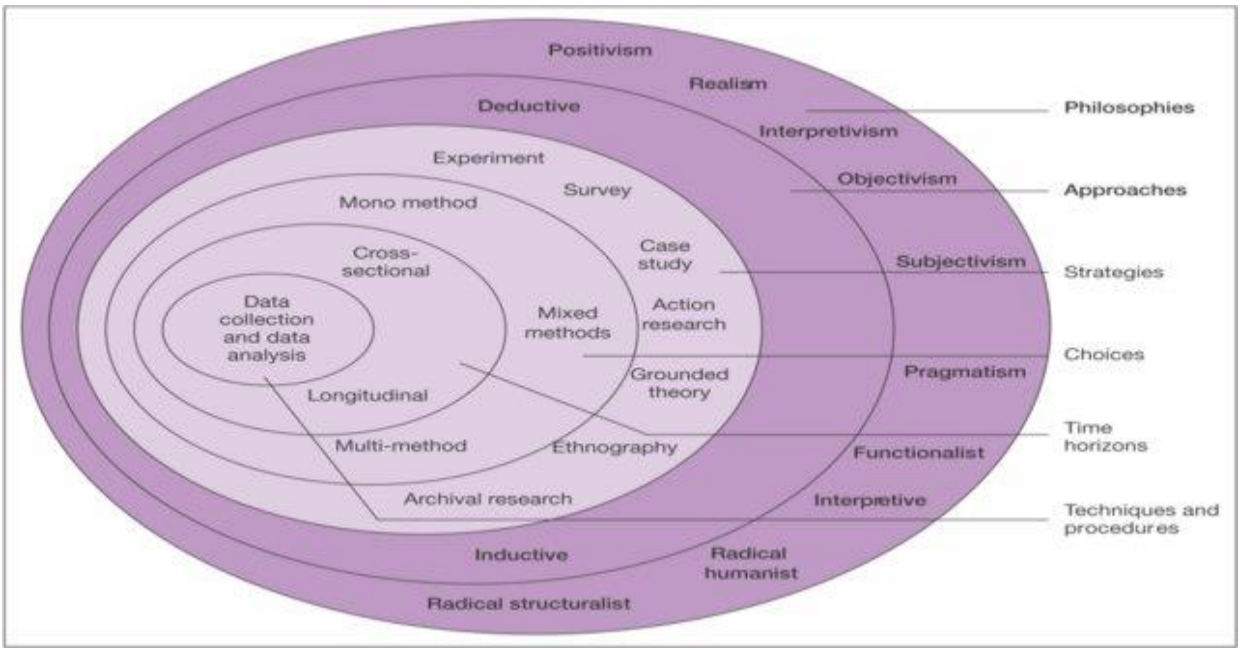

Figure 4 - Saunders Research Onion
(Source: https://research-methodology.net/research-philosophy)

iv) Use of data

The research outputs are varied and can have distinct uses. When designing a research project, the future use of the expected results shall be carefully analysed, and the type of outputs thoroughly chosen.

The most common way to convert data is to present the results obtained and the conclusions of the study in the format of a **scientific publication**. A scientific publication is a published piece of work that has been subjected to a **peer-review** process (a review and validation by other researchers, independent from the ones who have conducted the research) that communicates the results of given research to the public.

A great deal of the researchers' time is devoted to the publication of the results. Planning and scheduling publications helps organise and strategically direct research outputs. When publishing, it is important to consider which **scientific journals** are preferable. This requires researchers to compare journals/other publications and evaluate their potential impact (there are specific metrics for that, such as the **impact factor** of journals), to consider whether the journal is **open access** (free for all to read).

Scientific publications are generally read by other scientists who can understand the specificity of that piece of research. However, research results can be of interest to many other research stakeholders and serve other purposes than mere information directed to other scientists (this will be detailed in Module 4). For this reason, there are many other types of outputs from scientific research.

A non-exhaustive list includes:

- Patents, oral communications, spin-offs, companies, pilots, prototypes, mathematical models, software, algorithms, observatories, exhibitions, etc.

Research Lifecycle

The different stages and processes of conducting research form the **research lifecycle**, which starts with the development of the idea and planning the research and ends with the communication and use of the knowledge produced.

- **Planning** - conceiving the research idea and preparing a **research proposal**
- **Implementation** - developing the **research project**, from its inception to its completion
- **Spreading the word** - communicating project results (example: **research paper**)

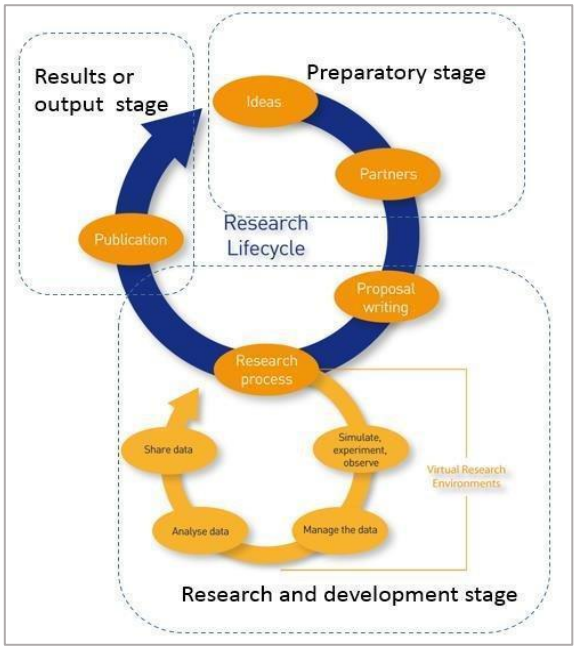

Figure 5 - A possible illustration of a research lifecycle

(Source: https://www.researchgate.net/publication/318696225_Embedding_library_services_in_research_stages_Chinese_subject_service_and_the_research_lifecycle_model/figures?lo=1)

For researchers, conducting research involves several periods of planning and writing, besides the moments of data collection and analysis. Most researchers will have to produce at least two different types of written work at different stages of the research lifecycle:

i) The **research proposal**. Whatever a researcher proposes to research, he/she is likely to need funding for equipment, supplies, transport, tuition fees, living expenses, and other expenses. Funding is generally granted by specialised funding agencies that award funding to the most competitive research projects. Applying for funding means entering a competition, often with other projects from around the world. To apply for funding, it is necessary to write a funding proposal that describes the **research project** to be carried out if the funding is approved.

ii) The **research output.** The outputs of the research will be made public in different formats such as a research essay, publications, communications or patent.

The structure of these two types of written pieces, despite addressing the same research question, is a bit different but with many similarities, as the proposal envisions the future while the research output describes what was already accomplished.

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