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

Learning outcomes

LO#2 - The student can distinguish and describe the types and specificities (aims, advantages, limits, appropriateness to certain disciplines) of main research methods that can be applied by different scientific areas (e.g. observation, survey, interview, focus group, experiments, etc).

LO#3 - The student should understand the research project lifecycle.

LO#4 - The student can identify the differences between a research design/plan and a research proposal.

LO#6 - The student can apply the stages of the research project lifecycle to a research plan, identifying the key questions to answer at each stage.

LO#7 - The student is able to recognise and integrate the motivations, expectations and role of a researcher.

LO#8 - The student is able to construct logical arguments to present a research idea.

LO#11 - The student is committed to find a balance between assertiveness and cooperation in the course of teamwork in research as a leader and as team member.

LO#12 - The student is open for different research methods and is committed to finding consensus in an interdisciplinary research setting.

LO#13- The student is open to perceive and accept the diversity of cultural and social context of research systems and practices.

Is there a scientific method that is common to all scientific disciplines? A method that pervades all sciences in implicit contrast with all the specialized methods for research that are used one in some sciences?

There is a difference between specialized methods and general principles. Precisely because specialized techniques are specialized, and each scientific discipline has its own set of specific 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 is research itself. In doing so, we addressed, despite superficially what is the scientific method, by introducing the ideas of controlled observation, inductive and deductive reasoning, formulation of hypotheses and experimentation.

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Let's focus on this lesson on the general principles that guide researchers from different fields into designing their research projects.

Research design

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

The design of the research will depend on the type and purpose of the research work. 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 a solution for those problems.

i) Identifying a research question

A clearly formulated 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 the researcher can have to hopefully solving that problem.
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, in which we narrow to a topic, and from there to a question that we can address. They come from theory, our own observations, and a variety of other sources.

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

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 needs oil to function);
- It can operate as a guide to a process of discovery (exploratory research)' (Halperin & Heath, 2012), to collect evidence and make inductive inferences from the evidence collected.

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

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

a. Observation and description of a natural or human phenomenon
b. Desk research (or literature review) about the topic pertaining to the research question
c. Ask a question and formulate a hypothesis to explain the phenomenon
d. Make a prediction for the hypothesis
e. Test/Experimenting the hypothesis
f. Drawing conclusions
g. Making recommendation 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. To conduct a literature review is a mandatory exercise when conducting research due to the following reasons:

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

iv) 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.

The most adequate scientific method to address a given research question, needs to take into consideration during its implementation 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 some 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 of a questionnaire. The data collected can be qualitative and quantitative, depending on the questions and the purposes of the research. Types

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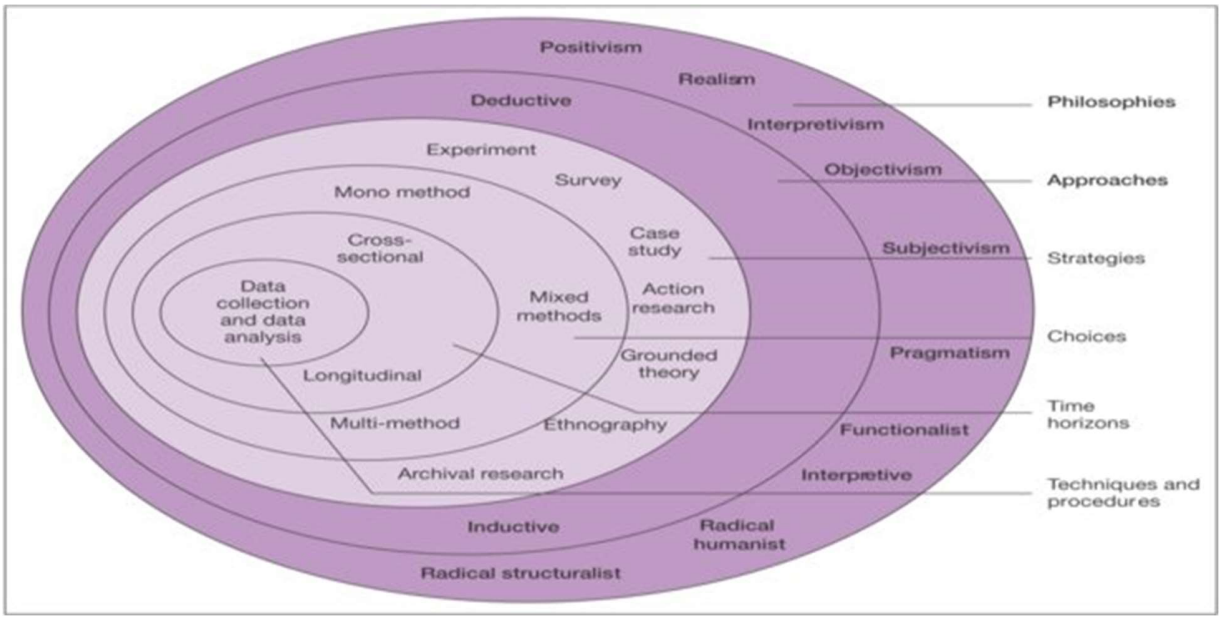
of surveys: Cross sectional survey, run on a regular basis but to different individuals, and longitudinal survey, run to the same individuals over time.

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 archival material, the analysis of social or traditional media, advertisements, films, political speeches, or policy documents.

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

The most used scientific methods 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 greater extent possible, only one factor can vary. In a laboratory, all conditions such as lightning, temperature, 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 cancel out of the analysis. 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) has developed the "Saunders Research onion" that illustrates the ways in which different elements involved in the research could be examined to develop the final research design, integrating many of the methods and approaches defined above.



Source: https://thesismind.com/analysis-of-saunders-research-onion/

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iv) The use of data

The outputs of the research work 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 carefully chosen.

The most common 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 subject to a **peer-review** process (a review and validations by other researchers, independent of the ones that have conducted the research work) that communicates to the public domain the results of a given research work.

An important part of the time of the researcher is devoted to the publication of the results. Planning and scheduling publication help organising and strategizing research outputs. When publishing, it is important to consider in which **scientific journal** to publish This requires to compare journals/other publications and to 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** (made public at no cost to the reader).

The scientific publications are generally read by other scientists who can understand the specificity of that piece of research. However, the research results can be of interest to many other stakeholders of research and to serve other purposes than merely to inform 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-off companies, pilots, prototypes, mathematical models, software, algorithms, observatories, exhibitions...

Research Lifecycle

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

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

For the researchers, doing research involves several periods of planning and writing, besides the periods when a researcher is collecting evidence and analysis data. Most researchers will have to write at least two different types of written work at different stages of the research lifecycle:

i) The **research proposal**. Whatever a researcher proposes to conduct research on, 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, So, applying for funding means entering a competition, often with other projects from anywhere in 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.

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

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

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