# Scientific Research:
# A Complex System of Interacting Processes

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Scientific research has two goals:

- Add to the body of knowledge to increase our understanding and ability to explain a phenomenon of interest -- social phenomenon in the case of social science. Scientists rely on theories to understand and explain and therefore by definition our tasks include development of theory.
- Use the knowledge, including theories, that we develop to help solve social problems, issues and needs

The graphic below shows the processes that are critical to scientific research.

- Each process is complex and each is equally critical in scientific research
- These processes interact with each other
- The combination of interacting processes constitutes a complex, multidimensional system for discovering new knowledge
- There is nothing simple about creating scientific knowledge

Each process is complex in its own right. I provide two examples and encourage you to think about all of the components in each of the processes in the graphic.

<u>Example 1: Develop Research Question & Objectives</u>

- The researcher must explain the problem, issue or need – based on existing scientific data -- before s/he can begin to develop the research question and objectives
- In practice the two processes interact and researchers move back and forth between them – for example, as the researcher struggles to develop a clear, robust research question s/he will often need additional information about the extent and nature of the problem, issue or need
- Once the topic of the research (problem, issue or need) is clear, the researcher moves on to explore the scientific literature about the phenomenon of interest, with a focus on the explanatory rather than the purely descriptive literature
- Only at this point can the researcher identify areas of conflicting *conclusions*, areas of *weakness or poorly developed conclusions*, and the oft-cited *lack of information*
- These areas provide the basis for identifying the objectives of the study that the researcher is developing

<u>Example 2: Develop the Sampling Protocol</u>

- This process interacts with the process of defining the population and with the process of developing instrumentation and developing data collection protocols.

- In practice, defining the population, developing the sampling protocol, and developing instrumentation for data collection interact almost continually
- As the researcher derives more precise (more screening criteria) definitions of the population, new considerations will arise for the sampling protocol
- As the researcher tries to develop appropriate data collection instruments, s/he will often realize that different instruments (wording, topics, order) may be needed for different subsets of the theoretical population (See Figure 2)

Scientific research design requires ***systems thinking***. Concentrating on just one of the many processes in design reduce the researcher's ability to draw conclusions that are (1) *reliable and trustworthy*, (2) generalizable to the theoretical population *as defined by the researcher*, and (3) add to the body of knowledge *through development of theory AND accumulation of reliable information (data and results).*

Assignments 2 and 3 in this class require that you consider the entire research system. When I ask if the research question is robust, you must at a minimum understand what the researcher says about these components:

- Evaluation of the efficacy outcomes of policies and practices – for example, do we have good solutions or can we improve the solutions we have now, is there a general public concern about the problem, are scientists concerned
- Our ability to not only describe but also explain the problem, issue or need of concern – has the nature of the problem changed, has it grown or decreased, have policy alternatives been tried and evaluated

To develop a robust research question and set of objectives, you also have to consider the theoretical basis for the research. Research questions are often quite broad – scientists may spend 10 or 15 years working on one or a few of these broad questions. Any given study addresses one or a few more specific questions frequently stated as objectives. You have to identify these questions. It is NOT in your purview to argue that the researcher should ask a *different question*. The research question is the responsibility of the researcher, not the reader. If you don't like the question, don't read the article.

Your work on Assignments 2 and 3 requires this kind of detailed consideration at every step. If you find yourself repeating the same ideas, you are "stuck" somewhere in this complex system of interacting processes. Sampling seems to be a "sticking point" for many teams. Sampling protocol (getting the sample) is ONE of many decisions the researcher has to make. It affects both internal and external validity – but so does the quality of the research question, the rigor of the analytic methods used, the quality of the conclusions that are drawn, and the severity of the problem, issue or need.

Please remember that *all of the research designs are valuable, none are 'generically bad.'* On the contrary, each is very *good* at providing specific types of conclusions. You have two main tasks in this regard. You need to assess whether the design is appropriate for the research question. You have to examine the rigor of execution of the design. Remember that design is the author's choice – not yours.

We will not discuss development of instrumentation in this class (Boxes 7 and 8 in the Research Cycle Diagram) and our discussion of data analysis is basic, not sophisticated. There are many courses for different types of data analysis. In this class, we focus on the basics. Do NOT comment on instrumention if you do not have a good background in this component of the research process. It is complex in and of itself – a whole different set of processes and interactions. Developing instrumentation does interact with research design – but I do not want to complicate this course by trying to address both research design and research methods in one course. In short, *I do not want you to base your decisions about the quality of a body of research based on the instrumentation and data analysis. Focus on the topics we discuss in detail.*

**Figure 1. The Basic Processes in the Scientific Research Cycle**