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*Research Methodology and
Scientific Writing*
Chem2072

Chapter One

**Introduction to Scientific
Research**

CONCEPT OF RESEARCH

- To re-search
- To re-examine
- To investigate
- To test
- To enquire

WHAT IS RESEARCH?

- Research is an investigative process of finding reliable solution to a problem through a systematic selection, collection, analysis and interpretation of data relating to the problem
- In other words research is all activities that makes us discover new knowledge about things around us.

Research is

- Knowledge acquisition gained
 - through reasoning
 - through intuition
 - but most importantly through the use of appropriate methods

The Scientific Research Method
(chapter 4)

Scientific Research

- A process of rigorous reasoning based on interactions among theories, methods, and findings;
- Builds on understanding derived from the objective testing of models or theories;
- Accumulation of scientific knowledge is laborious, plodding, circuitous, and indirect;
- Scientific knowledge is developed and honed through critique contested findings, replication, and convergence;
- Scientific knowledge is developed through sustained efforts;
- Scientific inquiry must be guided by fundamental principles.

Fundamental Principles

- I. Ask significant questions that can be answered empirically.
 - “The formulation of a problem is often more essential than it’s solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old questions from a new angle, requires creative imagination and marks real advance in science” (Einstein & Infeld, 1938);
 - The research questions must be asked in a way that allows for empirical investigation.

Fundamental Principles

II. Link research to relevant theory.

- Scientific research can be guided by a conceptual framework model, or theory that generates questions to be asked or answers to the questions posed;
- Theory drives the research question, the use of methods, and the interpretation of results.

Fundamental Principles

III. Select and apply research designs and methods that permit direct investigation of the question.

- The trustworthiness of any research study is predicated initially on several major elements:
 - o The suitability of the proposed research design or methodology to address the specific questions posed by the study;
 - o The scientific rigor by which the methodology is applied;

Fundamental Principles

- The trustworthiness of any research study is predicated initially on several major elements (cont'd):
 - The link between question and methodology must be clear and justified;
 - Detailed description of the method, measures, data collection procedures, data analyses, and subjects must be available to permit replication.

Fundamental Principles (cont'd)

IV. Provide a coherent and explicit chain of reasoning that can be replicated.

- ☐ What assumptions underlying the inferences were made? Were they clearly stated and justified?
- ☐ How was evidence judged to be relevant?
- ☐ How were alternative, competing hypotheses, and explanations identified, considered, and accounted for (accepted or discarded)?

Fundamental Principles (cont'd)

IV. Provide a coherent and explicit chain of reasoning that can be replicated (cont'd).

- How were the links between data and the conceptual or theoretical framework made?
- The chain of reasoning depends upon the design which depends on the type of question:
 - Description - what is happening?
 - Cause - is there a systematic effect?
 - Process/mechanism- why or how does the effect occur?

Fundamental Principles (cont'd)

V. Replicate and generalize across studies.

- Internal Validity: The observations made are consistent and generalize from one observer to another, from one task to a parallel task from one measurement occasion to another occasion.
 - Statistical methods - e.g. correlation;
 - Non-statistical methods - e.g. triangulation, comparative analysis.
- External Validity: The extent to which the treatment conditions and participant population reflect the "world" to which generalization is desired.

Fundamental Principles (cont'd)

VI. Report research publicly to encourage professional scrutiny, critique and replication.

- Criticism is essential to scientific progress;
- The extent to which new findings can be reviewed contested, and accepted or rejected by scientific peers depends upon accurate, comprehensive, and accessible records of:
 - o Data
 - o Methods
 - o Inferential reasoning

Common Conceptions/Misconceptions About Scientific Quality and Rigor

- Experimental research is more “scientific” than descriptive or qualitative research...
 - NOT TRUE: The type of design/method does not render the study scientific.

Common Conceptions/Misconceptions About Scientific Quality and Rigor (cont'd)

- ❖ A study is deemed to be “scientific” when:
 - There are a clear set of testable questions underlying the design;
 - The methods are appropriate to answer the questions and falsify competing hypotheses and answers;
 - The study is explicitly linked to theory and previous research;
 - The data are analyzed systematically and with the appropriate tools;
 - The data are made available for review and criticism.

Common Conceptions/Misconceptions

- ❖ Research in education is fundamentally different than in the “hard” sciences.
 - NOT TRUE: Scientific research in education, psychology, biochemistry, astrophysics, cultural anthropology, mathematics, etc., all:
 - Seek conceptual/theoretical understanding;
 - Pose empirical and testable and refutable hypotheses;
 - Design studies that test and rule out competing counter hypotheses;
 - Use observational methods that are linked to theory and can be publicly assessed for accuracy;
 - Recognize the importance of independent replication and generalization.

Summary

- ✓ What is research ?
- ✓ List out some fundamental principles used to for scientific inquire ?
- ✓ What are the importance's of linking research with theory ?
- ✓ Is Research in education is fundamentally different than in the "hard" sciences?
- ✓ When a study is considered to be "scientific" ?
- ✓ Is that experimental research is more "scientific" than descriptive or qualitative research?