

Guidelines for Initiating a Research Agenda: Research Design and Dissemination of Results

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LEARNING OBJECTIVES

1. Describe factors influencing the choice of research design.
2. Explain strengths and weaknesses of both quantitative and qualitative research methods.
3. Characterize descriptive, inferential, and survey research.
4. Describe the conventional scientific manuscript organizational structure.
5. Discuss the importance of and mechanisms for research findings dissemination.

ABSTRACT

Successful research outcomes require selection and implementation of the appropriate research design. A realistic sampling plan appropriate for the design is essential. Qualitative or quantitative methodology may be utilized, depending on the research question and goals. Quantitative research may be experimental where there is an intervention, or nonexperimental, if no intervention is included in the design. Causation can only be established with experimental research. Popular types of nonexperimental research include descriptive and survey research. Research findings may be disseminated via presentations, posters, and publications, such as abstracts and manuscripts.

ABBREVIATIONS: DV - Dependent variable, IV - Independent variable

INDEX TERMS: Authorship, manuscript preparation, publishing, qualitative research, quantitative research, research design

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INTRODUCTION

After selecting a research topic, an appropriate and feasible research design is crafted. The research design is driven by the hypothesis(es) or research question(s) generated from gaps in knowledge on the topic as suggested from the literature review. Factors to consider when choosing a research project are discussed in detail in a companion article in this issue.¹ The purpose of this article is to provide guidelines for implementing a research project including population sampling and decisions regarding quantitative versus qualitative analyses. Following implementation and completion of the research project, laboratory professionals are encouraged to disseminate significant findings through publications and/or presentations. Thus, abstract and manuscript preparation is also reviewed.

Sampling Plans

Sampling is the process of selecting a portion of the population to represent the entire population. The investigator identifies the target population, the population to whom the research outcomes are intended to apply by designating the study population, which is the entire set of individuals or objects having some common characteristics related to the research investigation. The study population may be broadly or narrowly defined; examples include human subjects, hospital records or laboratory data. The researcher specifically defines the eligibility criteria, which are the attributes of the target population, and defines how subjects are selected for participation. The accessible

population refers to those subjects who meet the eligibility criteria and are also available for the study; it is often a nonrandom subset of the target population. Probability sampling uses random procedures to select participants and is considered to be more representative of the population. Every element of the population has a known non-zero probability of being selected when using probability sampling. Simple random sampling is one type of probability sampling where each sample in population has an equal and independent chance of being selected. Systematic sampling is a convenient probability sampling method that uses a random sampling start and then every n^{th} sample is selected. Other types of probability sampling include stratified probability sampling and cluster sampling.

Nonprobability sampling uses nonrandom methods to select participants or sampling units. Every element does not have an equal chance of selection; thus, the sample may not be representative of the population. Convenience sampling is the weakest form of nonprobability sampling and is collected through networking or snowballing, where participants are selected through referrals or nominations of earlier participants. Purposive sampling or judgmental sampling recruits those individuals who represent "typical" groups who best address the research question based on their knowledge of the population and the problem. Quota sampling identifies strata from which data will be collected and then determines the proportions of elements required to obtain representation of diverse groups.²

Sample size is a common concern for researchers. How large must the study sample be in order for the study to be valuable? Larger samples permit for more rigorous statistical testing and permit subgroup analysis. However, smaller sample sizes are suitable for studies with homogeneous populations.² Once the suitable statistical procedure is chosen for interpretation of the results of a study; software is available to assist the researcher in determining the appropriate sample size for the study.

Research Designs

The researcher must determine if a quantitative or a qualitative approach is more suitable for a given project. In some cases, a mixed methods approach involving the collection of both quantitative and qualitative data is

needed to fully address a research question.³ Quantitative design uses deductive reasoning to develop specific predictions from general theory and results are used to reject, modify or support theory or a hypothesis. Qualitative design uses inductive reasoning as a basis to develop a theory. Relevant experiences and specific observations are used to form a theory that explains phenomena as they occur. Table 1 compares quantitative and qualitative research designs.

Table 1. Comparison of Quantitative and Qualitative Research Design

Characteristic	Quantitative	Qualitative
Subjects	Large sample size Control group	Small sample size
Investigator's Role	Detached	Intense contact with subjects
Purpose Design	Theory -testing Predetermined, structured, no change	Develop concepts General in nature Evolves during study
Characteristics	Begins with hypothesis or grounded theory Uses manipulation & Control Uses component analysis	Ends with hypothesis or grounded theory Uses emergence & portrayal Searches for patterns
Data	Quantifiable, statistical, and reduced to numerical indices	Descriptive, extensive, with minor use of numerical indices
Data Analysis	Hypothesis testing	Theory emerges from bottom up
Reasoning	Deductive	Inductive

Quantitative Research Design

Quantitative design involves the collection and analysis of quantitative data and includes experimental, quasi-experimental, descriptive, and survey research. Experimental design is the strongest of all research designs as it requires manipulation, control, and random assignment. Manipulation means that the researcher is an active participant applying an intervention and not only a passive observer. Through control, each subject is randomly assigned to either the experimental group, which receives the intervention or treatment, or to the control group, which does not receive the intervention and serves as a baseline against which to measure effects of the intervention. Random assignment means that each subject has an equal chance

of being included in either the treatment or the control group. Randomization eliminates systematic bias and creates comparable groups. Random assignment can be accomplished by a coin flip, table of random numbers or through computer randomization.

There are three types of experimental design. The simplest of designs, pre-experimental, involves an intervention applied to one more subject groups; the effect of the intervention on the outcome is subsequently measured. A pretest may or may not be included in the design. In pre-experimental design, there is no randomization or control group. Thus, with this design it is difficult to rule out alternative hypotheses, yet this design may be useful in pilot studies. Quasi-experimental design either lacks randomization or control groups but maintains

manipulation of the independent variable. Its weakness is the inability to establish cause and effect, and rival hypotheses must be considered.^{2,4} True experimental designs offer full control of the variables using experimental or statistical control methods. Therefore, it is the most powerful design to test a hypothesis because causality can be established. Because many human characteristics, such as diseases or health habits, cannot be randomly assigned and because some variables, such as medical treatments, cannot be technically or ethically manipulated, true experimental design may not always be appropriate. Types of true experimental and quasi-experimental design with examples are summarized in Table 2.

Nonexperimental Design

In a nonexperimental design, there is no manipulation

Table 2. True Experimental and Quasi-Experimental Designs

Type	TRUE EXPERIMENTAL DESIGNS	
	Characteristics	Example
Post test only or After only	Collect data only after intervention	What are the effects of antibiotic use on the carriage of <i>Staphylococcus aureus</i> in the anterior nares?
Pretest -Posttest or Before-After	Collect pre data, perform intervention, collect post data	What are the effects of a phlebotomy education program on reducing the contamination rate of blood cultures?
Factorial Design	Two or more variables at different levels Evaluation of main effects & interactive effects	What are the effects of group study and webinars on the performance of medical laboratory science students on a comprehensive examination? What effect does the number of student participants have on the outcome? Is the length and level of the webinar related to the outcome?
Repeated Measures Crossover Design	Subjects receive more than one intervention Serve as own control	What are the effects of diet and exercise on weight reduction?
Clinical Trials	Large, heterogeneous sample so can be generalized	What are the effects of an experimental chemotherapy in the treatment of lung cancer?.
QUASI-EXPERIMENTAL DESIGNS		
Posttest only or After only	No initial data No randomization	Is there decreased anxiety in college students who exercise three or more times per week?
Pretest-Posttest or Before-After	Nonequivalent control (comparison) group, No randomization, Pretest data, intervention, posttest data	What are the effects of the patient education on medication compliance?
Time Series	No control group No randomization Collect data over an extended period of time Can introduce and withdraw intervention	What is the effect of weekly aerobic exercise in stress reduction over a 10 week period in college freshman?

of the independent variable. Nonexperimental designs are useful when effects cannot be experimentally studied because of ethical or practical considerations or when human characteristics cannot be manipulated. In nonexperimental correlational studies, the researcher identifies the presence and strength of relationships among covariates. As one variable changes, the other is likely to change in the same or opposite direction. Correlation does not imply causality; thus cause and effect cannot be established using correlation studies.

Nonexperimental designs include retrospective studies which are also known as "Ex-post facto" or "after the fact" studies. An observation in the present measured as the dependent variable (DV) is linked to some phenomena that have occurred in the past, which is the independent variable (IV). For example, a researcher may wish to investigate possible causes of leukemia (DV) by investigating the subject's exposure to chemicals in the past (IV). Prospective nonexperimental design studies begin with a presumed cause (IV) and go forward to the presumed effect. A researcher may wish to determine if a student's grade point averages (IV) in high school can predict for the likelihood of college graduation (DV).

In descriptive research, the investigator's goal is to observe, describe and document the characteristics of the study subjects. Descriptive research involves the accurate portrayal of the characteristics of persons, situations, or groups and the frequency with which certain phenomena occur. Survey research is a type of non-experimental research that provides information on a group of subjects. This information may include the prevalence, distribution, and interrelationships of variables as well as actions, knowledge, intentions, opinions and attitudes of the subjects. Sampling methods for survey research include personal or face-to-face interviews, telephone interviews, self-administered questionnaires, and Web-based electronic surveys. Survey research is flexible and can be applied to many populations and to a large range of topics. However, the information collected may be superficial resulting in extensive, but not always intensive findings. Further, survey research does not establish causality.^{2,5}

Qualitative Research Design

Some research problems may be better studied using a qualitative research design approach. This may be the

case when a broad topic is poorly understood with a limited literature review. Gaining insight into human experience, thoughts, or behavior through the subjects' perspective allows the researcher to provide explanations for previously unexplained issues or to develop policy or practice guidelines. Qualitative research is useful for bridging the gap between scientific evidence and clinical practice. Green and Britten used the example of asthma treatment to demonstrate the impact of qualitative research on evidence based medicine and illustrate the importance of gathering information from a patient's perspective for treatment decisions.⁶ Qualitative research also provides a mechanism to develop or verify existing theory by developing a conceptual framework to explain phenomenon which is grounded in actual observations or a means to generate research questions. Published examples of the application of qualitative research in the area of transfusion medicine are provided by Arnold and Lane.⁷

Qualitative research proceeds in an iterative fashion. The researcher speaks with or observes a few people with firsthand experience of the study issue in a natural setting. Data may be collected through interviews, focus groups using unstructured or semi-structured formats, through participant observation, or document review. The research design is emergent and develops during the course of data collection.⁷

During the sampling process, selection of subjects for the study is purposeful and based on the ability of the subjects to confirm, challenge, modify, or enrich understanding of the problem. The sample is generally small and nonrandom with inclusion criteria established. Once no new information is obtained from the subjects, also referred to as data saturation, data collection is completed. The qualitative research process is summarized in Figure 1.

Grounded theory is the most common methodology for analyzing qualitative research data. Central to this methodology is the "searching for themes" as the data is analyzed. First, recurrent participant comments or observations enable major themes to be identified. Analysis proceeds by finding connections or relationships among the themes. As more subjects are studied and information gathered, the themes are refined. Lastly, a core theme, a "central phenomenon," with the ability to integrate all themes and validate

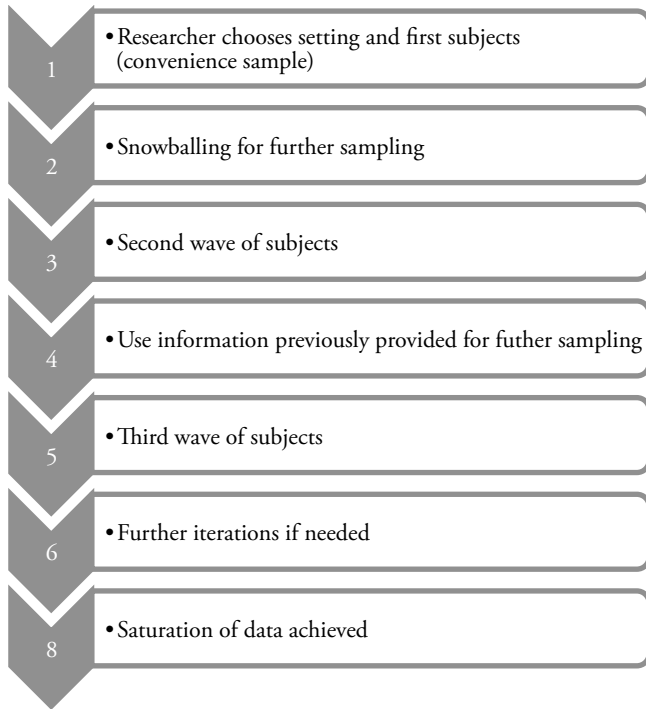


Figure 1. Waves of data collection for qualitative analyses.

relationships emerges. Validity verifies if the research undertaken truly measures that which it was intended to measure. Qualitative research is often validated through triangulation or the usage of two or more different data-collection methods (e.g., focus groups, interviews) concurrently, diverse groups of informants, or an array of documents as data sources to study the same question. Reliability refers to the extent to which results are an accurate representation of the study population and if these results can be reproduced using similar methods.⁸ Internal reliability can be strengthened by including multiple perspectives, peer scrutiny, multiple investigators, and participant researchers to verify that the coding assigned by the principle investigator matches the collected data. For more details pertaining the validity and reliability of qualitative research, Shenton provides strategies for ensuring trustworthiness of qualitative research.⁹

Dissemination of the Research Findings

Upon completion of the data collection and statistical analysis, the researcher next determines how to disseminate the findings. It is helpful to know what types of presentations or publications, such as abstracts or manuscripts are accepted as scholarly activity at your institution.

The Abstract

An abstract is a concise summary that may be an important component of a full article, but may also be a "stand alone" publication. A full article manuscript carries more scholarly strength than does an abstract; however an abstract may be the only research available on a given topic. Abstracts may also serve as a strong foundation for a research paper. Professional organizations request the submission of unpublished studies in abstract form, which can be presented as a lecture, poster, or technology presentation.

Abstracts present new or innovative findings that have not been previously published and have not been presented at other national scientific meetings. Abstracts must contain all important data, findings and conclusions. The organization's published guidelines for formatting and maximum word count must be followed. The submission is peer reviewed by a committee within the professional organization and either accepted or rejected. Types of abstracts include original studies, method or protocol evaluations, and case reports.⁴

The Manuscript

A manuscript reviews the entire thought process of research on a current topic, including background information and the current perspective. Its goal is to expand the knowledge base of the discipline.

Selection of the appropriate journal for submission of one's research is a critical decision. In fact, it is recommended that the author select the journal(s) before writing the paper. The research topic must "fit in" with the journal's goals and purpose. Items to consider include the writing style, subject matter included, the level of complexity, if basic or clinical research is accepted, and the level of statistics required. Consulting the journal's "Instructions to Authors" is essential to determine if the manuscript would be amenable to the journal. Reviewing these instructions with regard to writing style, page format, reference format, preparation of tables and figures, potential conflicts of interest, and permissions enables the author to prepare the manuscript in an acceptable fashion.^{4, 10}

Further consideration in selecting a journal relates to the types of authors and readers. First, the author must have acceptable credentials and significant expertise to

publish in the journal. Another consideration is the degree of exposure of the article and the ranking of the journal. The readership of the journal is another factor. If the journal is specialized, it may only be read by one group of health professionals. Journals with a broader scope may be read by a variety of health care professions, providing a larger audience. Ideally, the journal and article can be easily located through indexing with major reference sources and databases, such as Cumulative Index to Nursing and Allied Health (CINAHL).

In the peer review process, copies of the manuscript are sent to reviewers who are familiar with the subject area and considered expert consultants for the content. The reviewers read and critique the manuscript using a set of criteria that evaluates the merit of the article. Publishing in a peer-reviewed journal benefits the author because of the higher research standards and also benefits the reader because there is more confidence in the validity of the presented research.

Authorship

For manuscripts with multiple authors, a decision must be made to determine the primary author, and in which order the names of the contributing authors will appear. The duties of each author must be outlined clearly, so that each knows their responsibility in the manuscript. All contributing authors must proofread the manuscript, revise, and be able to discuss and to defend the manuscript. Only those individuals who were included on an Institutional Review Board (IRB) submission may be listed as an author. The primary author manages the revisions and prepares the final document for submission to the journal with input from all of the contributing authors.

Parts of the Manuscript

The Title of the paper introduces the topic and should catch the reader's attention. It should be concise and clear with all acronyms defined. Manuscript preparation begins with a detailed outline from which to develop the rough draft. The primary author prepares the rough draft with contributions from the other authors. The paper should be proofread and critiqued by all contributing authors; there may be several revisions until the final version is completed.

The Introduction describes the purpose and relevance of

the study and clearly states the hypothesis or the problem statement. Basic concepts are defined and key references that support the theoretical framework are cited. The introduction consists of one to two paragraphs and sets the stage for the methods section.

The Methods section describes the processes and methods used to answer the research question or to test the hypotheses. It is concise, yet sufficiently detailed so that the study can be duplicated. The IRB approval number, informed consent process, and descriptions of instruments, materials, measurements, sampling, data collection and analysis are included in this section.⁴

In the Results section, the basic data and results of statistical analysis are reported, using the past tense. The present tense implies that the results can be generalized to all populations, which is most likely not the case. Include the probability or "p" value (i.e., $p < 0.05$) when reporting statistical significance.

The Discussion section should not be used to repeat results, but instead to highlight noteworthy findings; results are interpreted and related to results from other similar studies. The reader is directed to critique the merits of this study in comparison to other published studies. Of critical importance is the need for the researcher to answer the original research question and to accept or to reject the original hypothesis. Implications, practical applications of the study, limitations, and problems encountered, and recommendations for future research are also discussed.⁹

The Conclusions must be supported by the research findings and thoroughly answer the research question or hypothesis. State the conclusions in rather tentative language, such as, "the study suggests that..." instead of "the study proved that...."

Next, the author can expand the Introduction, if appropriate, and write the Abstract, which is a condensed version of the manuscript with the same format. The abstract should include an introduction, methods, results, and conclusion presenting a concise review of the text of the full article. Information not within the text of the manuscript should not be included in the abstract.⁴

By reading and following the "Guidelines for Authors"

from the onset, the structure and format of the manuscript will require minimal format changes prior to submission. It is also helpful to use an author's checklist to verify that all items have been addressed. A suggested manuscript writing order is shown in Table 3.

Table 3. Suggested Manuscript Writing Order

1. Outline
2. Introduction (Brief)
3. Purpose & Hypothesis
4. Methods
5. Results
6. Discussion
7. Conclusion
8. Expand introduction
9. Abstract

Submission for Publication

After final reviews and revision by all contributing authors and another review of the Guideline's for Submission and Author Checklist, the manuscript is ready for submission. Most manuscripts are not accepted as submitted and do require revisions and clarifications. Manuscripts may be rejected if the required revisions are too extensive or if the subject matter does not align with the journal. After analyzing the reviewers' comments, determine if they are justified and address each comment succinctly and completely. The revised copy should be sent with an accompanying letter listing and addressing the reviewers' comments.

The submission for publication process is summarized in Figure 2.

Summary

Involvement in research and publication is an exciting and rewarding experience for medical laboratory professionals. Medical laboratory professionals possess the academic, clinical, and personal skill set required in research. An appropriate research design will provide the structure for a strong research project. Opportunities to disseminate research findings exist in the forms of presentations, abstracts, and manuscripts. Adherence to the journal's guidelines for authors can facilitate publication and contribute to the advancement of knowledge in the medical laboratory science field.

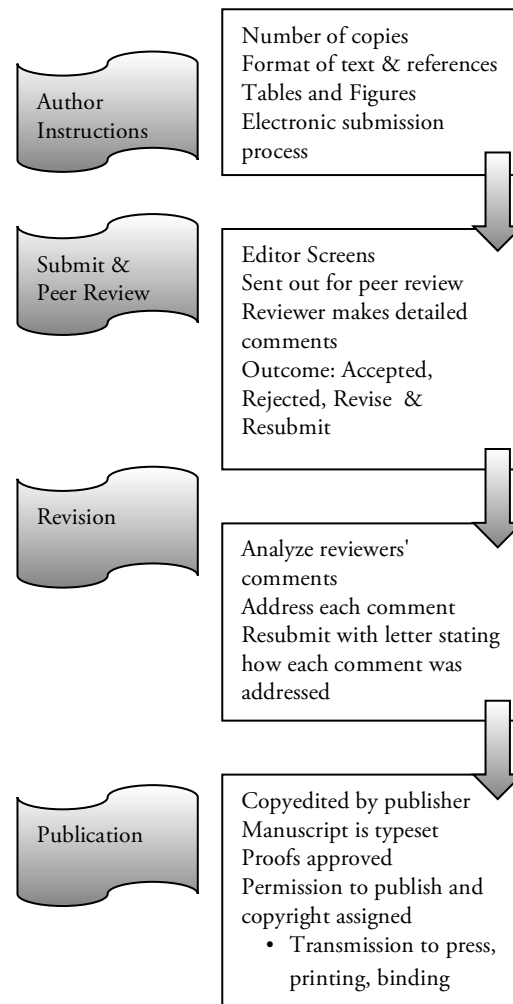


Figure 2. Process for submission of manuscripts for publication.

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